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European Assessment Document for

Thin metal composite sheets

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

The EAD applies to thin metal composite sheets (hereafter TMCS). TMCS consists of two thin layers of a metallic skin, which are sandwiching a thin solid core or a thin honeycomb core in a continuous co-extrusion process. The external face of metallic skin can be pre-coated or not. The joining of metallic skins with core is achieved either by an adhesive film or by a binder (chemical and mechanical action). Ranges of thickness of thin metal composite sheets are:

- 2 – 8 mm for TMCS made of a solid core[1]
- 6 – 20 mm for TMCS made of a honeycomb core[1]

TMCS is composed of:

- Facing skins made of:
  - Aluminium alloy sheets in accordance with EN 485-2[2] or EN 485-4, surface treated (coil coated in accordance with EN 1396, anodized in accordance with EN ISO 7599) or not, with nominal thickness of external/internal sheets (facing skins) ≥ 0.2 mm (± 8 %)[3].
  - Stainless steel sheets in accordance with EN 10088-1 or EN 10088-2 with nominal symmetric thicknesses of sheets (facing skins) from 0.2 up to 0.4 mm (± 5 %).
- Core made of:
  - Solid material: low-density polyethylene, or other polymer blended with or without flame retardant minerals, or minerals with binder.
  - Aluminium honeycomb.
- Continuous or discontinuous adhesive layer: For bonding faced skins to core through a continuous industrial process.

The product is not covered by a harmonized European standard (hEN).

The product is not covered by the following harmonised technical specification EN 14509, because thermal conductivity of its core is larger than specified one in Clause 1 of EN 14509 and the product is not intended as self-supporting element.

The product is not covered by EAD 090062-01-0404 Kits for external wall claddings mechanically fixed, because in the EAD 090062-01-0404 assessments are considered for families of kits and not for the TMCS alone-

The product TMCS with core made of aluminium honeycomb is not fully covered by EAD 210046-00-1201. Compared to the previous version of the EAD, the following changes are introduced:

- Thin metal composite sheets made of two thin layers of an aluminium skin, which are sandwiching a thin aluminium honeycomb core and had been added in a continuous co-extrusion process.
- The following new assessment method is added: Torque peel strength, determined in accordance with Clause 2.2.7.

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1 The mechanical behaviour model for the relevant manufacturer's stipulations e.g. with regard to the intended end use conditions, shall be considered and detailed in the ETA for the determination of the performances, provided that this mechanical behaviour has influence on the performance of the product covered by this EAD and, as long as the details of the assessment methods as laid down in this EAD, are respected. For this range of thickness, thin metal composite sheets can be considered closer to solid metal sheets, rather than to thicker sandwich panels, and usually calculation criteria considers tensile stresses at skins when exposed to flexural loads rather than shear resistance of the core.

2 All undated references to standards in this EAD are to be understood as references to the dated versions listed in chapter 4.

3 This is the minimum value covered by EN 485-2 (non-coated aluminium).

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations, e.g., with regard to the intended end use conditions, having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA as long as the details of the assessment methods as laid down in this EAD are respected.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The product (TMCS) is intended to be used for manufacturing of:

- Cladding elements: (cassettes/coffering, boards) in external and internal wall cladding kits.
- Parts (filling elements) of partition kits.
- Filling elements in external or internal supported ceilings.
- Rail filling.
- Permanently installed substrate boards for information and orientation systems.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of TMCS for the intended use of 25 years when installed in the works (provided that TMCS is subject to appropriate installation (see 1.1). These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer is to be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[4].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative, nor by EOTA when drafting this EAD, nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

1.3 Specific terms used in this EAD

1.3.1 Definitions

1.3.1.1 Cassette (coffering)

Spatial element made by (multi)folding of the edges, generally perpendicular to the face of original board, into requested shape and dimensions. Folded edges can be additionally joined together at the corners or not. Folded edges contribute to stiffness of element and its ability to distribute embedded loadings to supporting subframe. Element on its backside can contain attached additional internal reinforcement.

1.3.1.2 Skins

Covering parts of product made of flat, lightly corrugated or corrugated coated, metal sheets.

[4] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than referred to above.

1.3.1.3 Front skin

Skin (lacquered or not on its external side) of TMCS foreseen to bring the decorative aspect.

1.3.1.4 Core

Material positioned between two skins. This material can be solid (e.g., plastic or composite material) as well as honeycomb.

1.3.2 Symbols

σ_t	Tensile strength
$\sigma_{t,av}$	Average value of tensile strength
$\sigma_{t,k}$	Characteristic value of tensile strength
σ_m	Yield strength
$\sigma_{m,av}$	Average value of yield strength
$\sigma_{m,k}$	Characteristic value of yield strength
$\sigma_{mt,av}$	Average value of tensile strength perpendicular to faces
$\sigma_{mt,k}$	Characteristic value of tensile strength perpendicular to faces
σ_n	Standard deviation
$\sigma_{s,av}$	Average value of shear strength
$\sigma_{s,k}$	Characteristic value of shear strength
λ	Coefficient of thermal conductivity
φ_t	Creep coefficient
ΔT_h	Relative change of torque peel strength after hygrothermal cycles
$\Delta T_{i,6h,90°C}$	Relative change of torque peel strength after immersion for 6 hours in boiling water at 90 °C
$\Delta T_{i,500h,20°C}$	Relative change of torque peel strength after immersion for 500 hours in water at 20 °C
$\Delta T_{f/t}$	Relative change of torque peel strength after 50 freeze – thaw cycles
$\Delta T_{lt,80℃}$	Relative change of torque peel strength after exposure to heat for 2500 hours at hot dry air 80 °C
ΔR_h	Relative change of bending strength in four-point test arrangement after hygrothermal cycles
$\Delta R_{i,6h,90°C}$	Relative change of bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C
$\Delta R_{i,500h,20°C}$	Relative change of bending strength in four-point test arrangement after immersion for 500 hours in water at 20 °C
$\Delta R_{f/t}$	Relative change of bending strength in four-point test arrangement after 50 freeze – thaw cycles
$\Delta R_{lt,80℃}$	Relative change of bending strength in four-point test arrangement after exposure to heat for 2500 hours at hot dry air 80 °C

ε	Elongation
ε_{av}	Average value of elongation
$\varepsilon_{0,975}$	Two-sided confidence interval at the confidence level 95 % for elongation
$d_{0,975}$	Median and two-sided confidence interval of thickness
A	Area
E	Hard body impact energy
E_t	Tensile modulus of elasticity
$E_{t,av}$	Average value of tensile modulus of elasticity
$E_{t,0,95}$	One-sided bottom confidence level at the confidence level 95 % for tensile modulus of elasticity
E_{bend}	Bending modulus of elasticity in four-point test arrangement
$E_{bend,av}$	Average value of bending modulus of elasticity in four-point test arrangement
$E_{bend,0.95}$	One-sided bottom confidence level at the confidence level 95 % for bending strength in four-point test arrangement
F_m	Maximal force in failure
$F_{bend,INI}$	Breaking load in four-point test arrangement in initial state
$F_{flex,INI}$	Breaking load in three-point test arrangement
$g_{0,975}$	Two-sided confidence interval of apparent area density
G_{av}	Shear modulus of elasticity
$G_{0.95}$	One-sided bottom confidence level at the confidence level 95 % for shear modulus of elasticity
l_3	Total length of specimen type 1B in accordance with EN ISO 527-2, Cl. 6.1, Tab. 1 and Figure 1
L_0	Reference length of specimen type 1B in accordance with EN ISO 527-2, Cl. 6.1, Tab. 1 and Fig.1
$R_{bend,INI}$	Bending strength in four-point test arrangement in initial state
$R_{bend,INI,av}$	Average value of bending strength in four-point test arrangement in initial state
$R_{bend,INI,k}$	Characteristic value of bending strength in four-point test arrangement
$R_{flex,INI}$	Flexural strength in three-point test arrangement in initial state
$R_{flex,INI,av}$	Average value of flexural strength in three-point test arrangement in initial state
$R_{flex,k}$	Characteristic value of flexural strength in three-point test arrangement
$R_{h,av}$	Bending strength in four-point test arrangement after hygrothermal cycles
$R_{i,6h,90°C,av}$	Bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C

$R_{i,500h,20°C,av}$	Bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C
$R_{f/t,av}$	Bending strength in four-point test arrangement after 50 freeze – thaw cycles
$R_{lt,80℃,av}$	Bending strength in four-point test arrangement after exposure to heat for 2500 hours at hot dry air 80 °C
$s´$	Dynamic stiffness
T_l	Torque peel strength
T_{INI}	Torque peel strength in initial state
$T_{INI,av}$	Average value of torque peel strength in initial state
$T_{INI,0,975}$	Two-sided confidence interval of torque peel strength in initial state
$T_{h,av}$	Average value of torque peel strength after hygrothermal cycles
$T_{i,6h,90°C,av}$	Average value of torque peel strength after immersion for 6 hours in boiling water at 90 °C
$T_{i,500h,20°C,av}$	Average value of torque peel strength after immersion for 500 hours in water at 20 °C
$T_{f/t,av}$	Average value of torque peel strength after 50 freeze – thaw cycles
$T_{lt,80℃,av}$	Average value of torque peel strength after exposure to heat for 2500 hours at hot dry air 80 °C
V	Volume
V_x	Coefficient of variation of x

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1. Essential characteristics of the product

Table 2.1.1 shows how the performance of the TMCS is assessed in relation to the essential characteristics.

Table 2.1.1: Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No.	Essential characteristic	Assessment method	Type of expression of product performance *(level, class, description)*
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	2.2.1	Class
Basic Works Requirement 3: Hygine, health and the environment			
2	Content, emission and/or release of dangerous substances	2.2.2	Description
Basic Works Requirement 4: Safety and accessibility in use			
3	Tensile resistance • Core included: Tensile strength Yield strength Elongation Tensile modulus of elasticity • Without core: Tensile strength Yield strength Elongation	2.2.3	Level
4	Tensile strength perpendicular to the face	2.2.4	Level
5	Flexural performance • Bending strength in four-point test arrangement • Bending modulus of elasticity in four-point test arrangement • Flexural strength in three-point test arrangement	2.2.5	Level
6	Shear performance • Shear strength • Shear modulus of elasticity	2.2.6	Level
7	Torque peel strength	2.2.7	Level
8	Hard body impact resistance	2.2.8	Level / Description
Basic Works Requirement 5: Protection against noise			
9	Dynamic stiffness	2.2.9	Level
Basic Works Requirement 6: Energy economy and heat retention			
10	Coefficient of thermal conductivity	2.2.10	Level
Aspects of durability			
11	Durability • Hygrothermal behaviour • Effect of immersion for 6 h in boiling water at 90ºC • Effect of immersion for 500 h. in water at 20º C • Effect of freeze-thaw cycles • Effect of long-term exposure to heat (2500 hours at hot dry air 80 °C) • Creep test	 2.2.11.1 2.2.11.2 2.2.11.3 2.2.11.4 2.2.11.5 2.2.11.6	 Level / Description Level / Description Level / Description Level / Description Level / Description Level

2.2. Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

This chapter is intended to provide instructions for TABs. Therefore, the use of wordings such as “shall be stated in the ETA” or “it has to be given in the ETA” shall be understood only as such instructions for TABs on how results of assessments shall be presented in the ETA. Such wordings do not impose any obligations for the manufacturer and the TAB shall not carry out the assessment of the performance in relation to a given essential characteristic when the manufacturer does not wish to declare this performance in the Declaration of Performance.

When shape adjustment of test specimens is needed, samples shall be cut from TMCS using water jet cutting machine, or vertical saw, or computer numerical control devices. All tests shall be performed at normal laboratory environment (+23 ± 2) °C and RH (50 ± 10) % (class 2) in accordance with EN ISO 291, Clause 6, if relevant test procedure does not specify other conditions. Test specimens shall be conditioned in laboratory environment for 24 hours before the test, if test procedure does not specify otherwise.

For the TMCS with faced skins of same thickness and which are produced in more than one thickness, the tests shall be performed at least on specimens of maximal and minimal product thickness. Therefore, at least both minimal and maximal results shall be given in the ETA.

2.2.1. Reaction to fire

Purpose of the assessment

The purpose of the assessment is to provide the reaction to fire of the TMCS.

Assessment method

The TMCS shall be tested, using the method(s) relevant for the corresponding reaction to fire class in accordance with EN 13501-1. The TMCS shall be classified in accordance with the Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1. The mounting and fixing conditions for the tests are specified in Annex A.

Expression of results

The reaction to fire class of the product shall be stated in the ETA together with those conditions for which the classification is valid.

2.2.2. Content, emission and/or release of dangerous substances

To determine the performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances. The TMCS will be assessed on the basis of the information provided by the manufacturer[5] after identifying the release scenarios (see Annex 1 of GD 14 "Scenarios for the intended use") taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market.

The identified intended release scenarios for this product and intended use with respect to dangerous substances are:

- IA1: Product with direct contact to indoor air.

[5] The manufacturer may be asked to provide to the TAB the REACH related information which he must accompany the DoP with (cf. Article 6(5) of Regulation (EU) No 305/2011). The manufacturer is not obliged:
- To provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- To provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous in accordance with Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS.

Any information provided by the manufacturer regarding the chemical composition of the products may not be distributed to EOTA or to TABs.

- S/W1: Product with direct contact to soil, ground and surface water.
- S/W2: Product with indirect contact to soil, ground and surface water.

2.2.2.1. SVOC and VOC

Purpose of the assessment

The purpose of the assessment is to provide the SVOC and VOC of TMCS for their impact on indoor air.

Assessment method

For the intended use covered by the release scenario IA1 semi-volatile organic compounds (SVOC) and volatile organic compounds (VOC) shall be determined in accordance with EN 16516. The loading factor [1 m^2/m^3] used for emission testing shall be taken from Table 2.2.2.1.1.

Table 2.2.2.1.1 Loading factor L, depending on the product type (in accordance with EN 16516)

Intended use	Loading factor
Walls	1.0
Ceiling	0.4

Inorganic products, without intentionally added organic compounds do not have to be tested

The preparation of the test specimen is performed by using a representative sample of the product installed in accordance with the manufacturer's product installation instructions or in absence of such instructions the usual practice of the product installation.

Once the test specimen has been produced, as described above, it should immediately be placed in the emission test chamber. This time is considered the starting time of the emission test.

The test results have to be reported for the relevant parameters (e.g. chamber size, temperature and relative humidity, air exchange rate, loading factor, size of test specimen, conditioning, production date, arrival date, test period, test result) after 3 and/or 28 days testing.

Expression of results

The TMCS performance shall be stated in the ETA [unit mg/m_3].

2.2.2.2. Leachable substances

Purpose of the assessment

The purpose of the assessment is to provide the leachable substances of TMCS for direct and indirect impacts on ground, soil and external water.

Assessment method

A leaching test with subsequent eluate analysis shall take place, each in duplicate. Leaching tests of the cladding element conducted in accordance with EN 16637-2. The leachant shall be pH-neutral demineralised water and the ratio of liquid volume to surface area shall be (80 ± 10) l/m^2.

Specimens shall be prepared in accordance with Clause 8.2 of EN 16637-2.

In eluates of "6” hours“ and "6” days", the following biological tests shall be conducted:

- Acute toxicity test with Daphnia magna Straus in accordance with EN ISO 6341.
- Toxicity test with algae in accordance with EN ISO 15799.
- Luminescent bacteria in accordance with EN ISO 11348-1, EN ISO 11348-2 or EN ISO 11348-3.

For each biological test, EC20-values shall be determined for dilution ratios 1:2, 1:4, 1:6, 1:8 and 1:16.

If the parameter TOC is higher than 10 mg/l, the following biological test shall be conducted with the eluates of "6 hours" and/or "64 days" eluates:

- Biological degradation in accordance with OECD Test Guideline 301 part A, B or E.

Expression of results

Determined toxicity in biological tests shall be expressed as EC20-values for each dilution ratio. Maximum determined biological degradability shall be expressed as "…% within …hours/days". The respective test methods for analysis shall be specified.

2.2.3. Tensile performance

Purpose of the assessment

The purpose of the assessment is to provide the tensile performance (expressed as tensile strength, yield strength, elongation and modulus of elasticity) of the TMCS.

Assessment method

The tensile performance shall be determined on two sets consisting of five test specimens at least.

Test shall be performed on one set of test specimens with continuous core and on one set of test specimens with discontinued core.

The shape and dimensions of test specimen of type 1B in accordance with in EN ISO 527-2, Clause 6.1, Tab. 1 and Figure 2.2.3.1, with total length l_3 = 200 mm and gauge length l_0 = 50 mm shall be used.

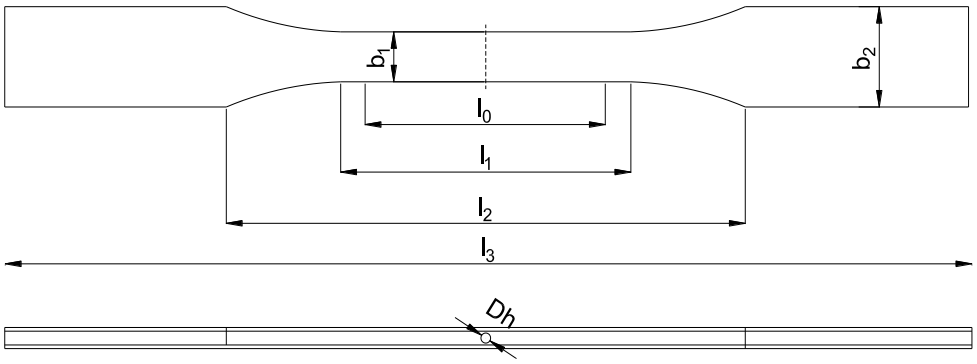


Figure 2.2.3.1: *Schema of perforated test specimen type 1B*

Discontinuation of core shall be performed by drilling the core in prepared test specimens in the centre of the axis of gauge length, in axial plane parallel with surface of specimen. The nominal diameter D_h of the drill bit shall be equal to nominal thickness of specimen minus nominal thickness of its core. Residuum of the core in bored hole shall be removed carefully, allowing a thin core fringe around the hole.

The skin must not be damaged by drilling, otherwise the specimen shall be discarded.

All test specimens shall be conditioned according EN ISO 527-1, Clause 8, for 16 hours at least and controlled in accordance with EN ISO 16012. Dimensions of cross-section of gauge length shall be recorded.

Then the test of tensile performance in accordance with EN ISO 527-1, Clause 9 with test speed 1 mm/min (EN ISO 527-2, Clause 8) with external deformation measurement (EN ISO 527-1, Clause 10.2.1) is to be performed.

Separate values of tensile strength σ_t [MPa] and yield strength σ_m [MPa] in accordance with EN ISO 527-1, Clause 10.1; elongation ε [%]in accordance with EN ISO 527-1, Clause 10.2.1 and modulus of elasticity E_t [GPa] in accordance with EN ISO 527-1, Clause 10.3.2 shall be calculated.

Tensile strength and yield strength of set of test specimens with discontinued core shall be evaluated from total thickness of faced skins only.

Tensile modulus of elasticity shall be tested and evaluated only for set of test specimens with core.

The following characteristics with regard to provisions of EN ISO 527-1, Clause 10.5 and 10.6 shall be calculated separately for case with core (index “cplx” - ComPLeX) and without core (index “sans”):

- Average values and estimation of standard deviation σ_n of tensile strength $\sigma_{t,av}$ [MPa], yield strength $\sigma_{m,av}$ [MPa], elongation ε_{av} [%] and tensile modulus of elasticity $E_{t,av}$ [GPa].
- Characteristic values of tensile strength $\sigma_{t,k}$ and yield strength $\sigma_{m,k}$, given in [MPa] as 95 % quartile on confidence level 75 % for V_x as unknown in accordance with EN 1990, Annex D, Clause 7.2.
- One-sided bottom confidence level at the confidence level 95 % in accordance with ISO 2602, Clause 6.2 for tensile modulus of elasticity $E_{t,0,95}$ [GPa] for case with core only.
- Two-sided confidence interval at the confidence level 95 % in accordance with ISO 2602, Clause 6.2 for elongation $\varepsilon_{0,975}$ [%].

Expression of results

The following characteristics shall be given separately for the product with and without core in a table in the ETA:

- Average value of tensile strength $\sigma_{t,av}$ [MPa], estimation of standard deviation σ_n, characteristic value $\sigma_{t,k}$ [MPa].
- Average value of yield strength $\sigma_{m,av}$ [MPa], estimation of standard deviation σ_n, characteristic value $\sigma_{m,k}$ [MPa].
- Average value of elongation ε_{av} [%], estimation of standard deviation σ_n [%], two-sided confidence interval $\varepsilon_{0,975}$ [%].
- Only for test with core: average value of tensile modulus of elasticity $E_{t,av}$ [GPa], estimation of standard deviation σ_n [GPa], one-sided bottom confidence level $E_{t,\ 0,95}$ [GPa].

2.2.4. Tensile strength perpendicular to face

Purpose of the assessment

The purpose of the assessment is to provide the tensile strength perpendicular to face of TMCS.

Assessment method

Tensile strength perpendicular to face shall be determined on at least five test specimens by testing in accordance with the test method given in Annex C.

The following characteristics of tensile strength perpendicular to face with regard to provisions of EN ISO 527-1, Clause 10.5 and 10.6 are to be calculated:

- Average value $\sigma_{mt,av}$ and estimation of standard deviation σ_n .
- Characteristic value of tensile strength perpendicular to face $\sigma_{mt,k}$, given as 95 % quartile on confidence level 75 % for V_x as unknown in accordance with EN 1990, Annex D, Clause 7.2.

Expression of results

The following characteristics shall be stated separately in table in the ETA:

- Average value of tensile strength perpendicular to face $\sigma_{mt,av}$ [MPa], estimation of standard deviation σ_n [MPa], characteristic value $\sigma_{mt,k}$ [MPa].

2.2.5. Flexural performance

Purpose of the assessment

The purpose of the assessment is to provide the flexural performance of TMCS by four and three points bending test arrangements (expressed as bending strength and bending modulus of elasticity) of TMCS.

Assessment method

2.2.5.1. Bending performance in four-point test arrangement

Bending strength and bending modulus of elasticity both in four-point test arrangement, at initial state, shall be determined by testing of six test specimens of dimensions 400 x 100 mm [±0,5 mm].

The bending strength in four-point test arrangement of the TMCS in initial state shall be tested in normal laboratory conditions (23 ± 2°C; 50 ± 5% RH) with schema of load distribution given on Figure 2.2.5.1.1.

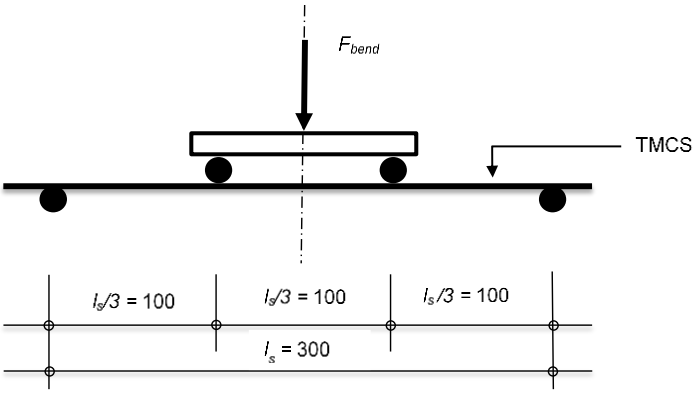


Figure 2.2.5.1.1: Schema of load distribution of bending performance in four-point test arrangement

Test specimen shall be placed on support with two cylindrical braces of diameter 20 mm attached to in span of 300 mm. The test device, consisting of two cylindrical braces of diameter 20 mm attached to rail in distance of 100 mm, distributing test load from test machine into test specimen, shall be fixed to traverse of test machine to avoid additional load.

Bending test shall be performed on universal test machine of class 0.5 with application of load at uniform speed of 5 mm/min. Deflection shall be measured in the middle of span by appropriate measurement device with accuracy 0.01 mm in minimum. Test is stopped when breakage or irreversible deflection of test specimen occur.

Single values of test load at failure in four-point test arrangement in initial state $F_{bend,INI}$ [kN] and working diagram F_{bend} / f_m (i.e. load / deformation in the middle of span) shall be recorded.

The bending strength in four-point test arrangement in initial state $R_{bend,INI}$ [MPa] shall be calculated for each test specimen in accordance with equation:

$$R_{bend,INI} = \frac{F_{bend,INI} \times l_s}{b \times t^2}$$

where
- $F_{bend,INI}$ is the breaking load in four-point test arrangement in initial state, in N;
- l_s is the span between the axis of support, in mm;
- b is the width of the test specimen, in mm;
- t is the total thickness of TMCS, in mm.

The average value $R_{bend,INI,av}$ and estimation of standard deviation σ_n of bending strength at failure in four-point test arrangement shall be calculated.

The bending modulus of elasticity in four-point test arrangement E_{bend} shall be calculated and expressed in [GPa] for each tested specimen according to the following equation:

$$E_{bend} = 0{,}213 \times \frac{{l_s}^3}{b \times t^3} \times \frac{(F_2 - F_1)}{(f_2 - f_1)}$$

where F_2 and F_1 are loads, taken from two points within the linear section of the plot, below the limit of proportionality (10 % - 40 % of F_{max}), in kN;

l_s is the span between the axes of supports, in mm;

b is the width of the test specimen, in mm;

t is the total thickness of the test specimen, in mm;

f_1 and f_2 are deflections corresponding to the selected loads F_1 and F_2, in mm, taken from working diagram.

If front and rear skins of TMCS differs, test of bending strength in four-point arrangement shall be performed and evaluated for each facing separately.

Average value $E_{bend,av}$ and estimation of standard deviation σ_n of bending modulus of elasticity in four-point test arrangement shall be calculated.

The following characteristics with regard to provisions of EN ISO 527-1, Clauses 10.5 and 10.6 shall be calculated:

- Characteristic value of bending strength in four-point test arrangement $R_{bend,INI,k}$ given as 95 % quartile on confidence level 75 % for V_x as unknown in accordance with EN 1990, Annex D, Clause 7.2.
- One-sided bottom confidence level at the confidence level 95 % in accordance with ISO 2602, Clause 6.2 for bending modulus of elasticity in four-point test arrangement $E_{bend,0.95}$.

Expression of results

The following characteristics shall be given separately for the product in table in the ETA:

- Average value of bending strength in four-point test arrangement $R_{bend,INI,av}$ [MPa], estimation of standard deviation σ_n [MPa], characteristic value $R_{bend,INI,k}$ [MPa].
- Average value of bending modulus of elasticity in four-point test arrangement $E_{bend,av}$ [GPa], estimation of standard deviation σ_n [GPa], one-sided bottom confidence level $E_{bend,0.95}$ [GPa].

2.2.5.2. Bending strength in three-point test arrangement

Assessment method

Bending strength in three-point test arrangement in initial state shall be determined on six test specimens of dimensions 300 × 50 mm.

The bending strength in three-point test arrangement in initial state is to be tested in accordance with EN 12467, Clause 7.3.2.3, in normal laboratory conditions (23 ± 2°C; 50 ± 5% RH).

Single values of test load in at failure three-point test arrangement $F_{flex,INI}$ [kN] shall be recorded.

The bending strength in three-point test arrangement in initial state $R_{flex,INI}$ [MPa] shall be calculated for each test specimen according to equation:

$$R_{flex,INI} = \frac{3 \times F_{flex,INI} \times l_s}{2 \times b \times t^2}$$

where $F_{flex,INI}$ is the breaking load in three-point test arrangement, in N;

l_s is the span between the axis of support, in mm;

b is the width of the test specimen, in mm;

t is the total thickness of the test specimen, in mm.

Average value $R_{flex,INI,av}$ and estimation of standard deviation σ_n of flexural strength in three-point test arrangement shall be calculated.

If front and rear skins facing of TMCS differs, test of flexural strength in three-point arrangement shall be performed and evaluated for each facing separately.

The following characteristic with regard to provisions of EN ISO 527-1, Clause 10.5 and 10.6 shall be calculated:

- Characteristic value of flexural strength in three-point test arrangement $R_{flex,k}$, given as 95 % quartile on confidence level 75 % for V_x as unknown in accordance with EN 1990, Annex D, Clause 7.2.

Expression of results

The following characteristics shall be given for the product in the ETA:

- Average value of flexural strength in three-point test arrangement $R_{flex,INI,av}$ [MPa], estimation of standard deviation σ_n [MPa], characteristic value $R_{flex,k}$ [MPa].

2.2.6. Shear performance

Purpose of the assessment

The purpose of the assessment is to provide the shear performance of TMCS.

Assessment method

The shear strength and shear modulus of elasticity of the TMCS shall be determined on five test specimens at least by testing in accordance with the test method given in Annex D.

The following characteristics with regard to provisions of EN ISO 527-1, Clauses 10.5 and 10.6 shall be calculated:

- Average values and estimation of standard deviation σ_n of shear strength $\sigma_{s,av}$ and shear modulus of elasticity G_{av} .
- Characteristic value of shear strength $\sigma_{s,k}$, given as 95 % quartile on confidence level 75 % for V_x as unknown in accordance with EN 1990, Annex D, Clause 7.2.
- One-sided bottom confidence level at the confidence level 95 % in accordance with ISO 2602, Clause 6.2 for shear modulus of elasticity $G_{0.95}$.

Expression of results

The following characteristics shall be given separately in table in the ETA:

- Average value of shear strength $\sigma_{s,av}$ [MPa], estimation of standard deviation σ_n [MPa], characteristic value $\sigma_{s,k}$ [MPa].
- Average value of shear modulus of elasticity G_{av} [MPa], estimation of standard deviation σ_n [MPa], one-sided bottom confidence level $G_{0.95}$ [MPa].

2.2.7. Torque peel strength

Purpose of the assessment

The purpose of the assessment is to provide the delamination resistance of TMCS by peeling strength test.

Assessment method

The peel strength at initial state shall be determined on six test specimens.

Then samples shall be tested in accordance with the method given in Annex E, in normal laboratory conditions (23 ±2°C; 50±5% RH).

Single values of torque peel strength in initial state T_{INI} [N.m/m] shall be calculated.

Expression of results

The average value $T_{INI,av}$ [N.m/m], estimation of standard deviation σ_n [N.m/m] and two-sided confidence interval of torque peel strength in initial state $T_{INI,0,975}$ [N.m/m], shall be calculated and stated in the ETA.

2.2.8. Hard body impact resistance

Purpose of the assessment

The purpose of the assessment is to provide the impact resistance of TMCS by hard body impact test.

Assessment method

The test of resistance to hard body impact for given thickness of the TMCS is to be performed in accordance with ISO 7892 with amendments and modifications as described in Annex F on two sets consisting at least of three test specimens for given nominal thickness.

The test shall be performed on one set conditioned for 24 hours at normal conditions 23/55 and on one set conditioned for 24 hours at -20 °C.

Hard body impact shall be applied to the exposed (outer) surface of the TMCS. The dimensions of test specimens are given in Annex F.

The hard body impact resistance shall be tested for impact energy 1; 3; 5 and 10 N*m. Before start of test manufacturer can select one or more levels from this range of impact energy for performing of test. If he doesn't, all impact energies shall be tested.

The hard body impact resistance is expressed as impact energy E [J], which caused no damage (no collapse, no penetration, no projection and no degradation) of any of 3 test specimens.

Expression of results

Hard body impact energy E [J] that caused no damage on the TMCS shall be given for given nominal thickness in the ETA.

2.2.9. Dynamic stiffness

Purpose of the assessment

The purpose of the assessment is to provide the dynamic stiffness of TMCS.

Assessment method

The dynamic stiffness for given thickness of TMCS shall be performed on test specimens by testing in accordance with the test method given in ISO 9052-1 as described in Fig.2.2.11. The dimensions and number of test specimens are given in ISO 9052-1, Clause 6.

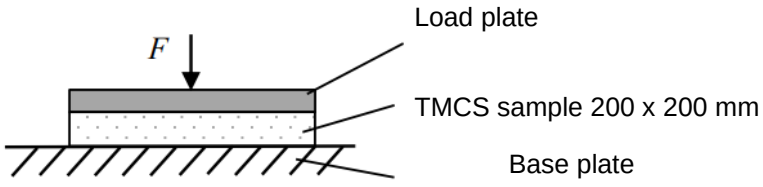


Figure 2.2.9: Schema of excitation measurement of load plate

Expression of results

The dynamic stiffness s' [MPa/m] of TMCS shall be stated in the ETA.

2.2.10. Coefficient of thermal conductivity of the solid core

Purpose of the assessment

The purpose of the assessment is to provide the thermal conductivity of TMCS.

Assessment method

The coefficient of thermal conductivity for given thickness of TMCS shall be determined on two test specimens by testing in accordance with the test method given in EN 12664. The dimensions and number of test specimens shall be in accordance to EN 12664, Clause 6.

Test specimens shall be conditioned I to 105-110 ºc inside an oven place in room at 23±2 ºC and 50±5% RH, in accordance to EN 12664, Clause 7.2.2, until constant mass is reached. The specimens shall not present any defect in its flatness, before testing, and edges shall be sealed carefully covering joint between skins and core.

Expression of results

The coefficient of thermal conductivity λ [W/(m.K)] of TMCS shall be stated in the ETA.

2.2.11. Durability

The durability of TMCS based on solid or honeycomb cores shall be determined for at least, minimum, intermediate and maximum thicknesses of TMCS, by the decay of the initial bending strength in four-point arrangement (obtained in accordance with Clause 2.2.5.1) and by the decay of the initial peeling strength (obtained according to Clause 2.2.7) after ageing procedures. Previously to any ageing, specimens shall be cut 23 (± 2) °C and 50 (± 5) % RH. No particular instruction for each type of TMCS is required.

- Hygrothermal behaviour.
- Effect of immersion for 6 hours in boiling water at 90 °C.
- Effect of immersion for 500 hours in water at 20 °C.
- Effect of freeze-thaw cycles.
- Effect of long-term exposure to heat (2500 hours at hot dry air 80 °C).
- Creep test.

2.2.11.1. Hygrothermal behaviour

Purpose of the assessment

The purpose of the assessment is to provide hygrothermal behaviour of TMCS by testing after exposure to hygrothermal cycles:

- Torque peel strength after hygrothermal cycles in accordance with 2.2.11.1.1.
- Bending strength in four-point test arrangement in accordance with 2.2.11.1.2.

Ageing method

The hygrothermal behaviour of the TMCS shall be determined on 6 specimens per test, after being conditioned and then exposed to the option most representative of the intended use as described below:

- Option1: For external exposures where minimum temperature reaches-20ºC or internal exposure at use which could be temporally exposed to -20ºC.
- Option 2: For external exposures where minimum temperatures reaches -40ºC.

Specimens shall be distanced each other at least 25 mm, placed vertically or horizontally over a perforated rack. In this last case with its front skin facing down. Considering as initial conditions 23 (± 2) °C and 50 (± 5) % RH, and increase in humidity shall be applied at a heating rate of 1.5 ºC/min in order to start the hygrothermal cycles as follows:

Option 1: Lowest temperature foreseen condition: -20 ºC:
- Exposure to temperature and humidity 90 °C and 90% RH along 1 h.
- Decrease of temperature to -20 (± 2) ºC) along 2 h.
- Exposure to temperature -20 (± 2) °C along 1 h.
- Increase of temperature and humidity up to +90 ºC and 90 % RH along 1 ½ h.

Total: 6 h / cycle.

Option 2: Lowest temperature foreseen condition: -40 ºC:
- Exposure to temperature and humidity 90 °C and 90% RH along 1 h.
- Decrease of temperature to -40 (± 2) °C along 2 h.
- Exposure to temperature -40 (± 2) °C along 1 h.
- Increase of temperature and humidity up to +90 ºC and 90 % RH along 1 ½ h.

Total: 6 h / cycle.

Eight cycles shall be carried out uninterruptedly.

For TMCS which are produced in more than one thickness, the tests shall be carried out on 6 specimens of both maximum and minimum thickness. The worst result shall apply to thicknesses.

This equipment shall be used:

- Climatic chamber with internal dimensions able to contain different sizes of steps and ranges of temperatures described above.
- Rack / Shelves: To support the test specimens and enabling a uniform heating exposition with dimensions to fix the test specimens.

This procedure shall be followed:

- Introduce specimens and start cycle tests according to required conditions.
- After the end of the eight cycle as of the Clause 2.2.11.1 specimens shall be removed from climatic chamber and left in the ambient temperature (e.g., 23 ± 2 °C) allowing for cooling rate smaller than 1.5 ºC/min before further testing.

Then, the following tests shall be carried out:

- Torque peel strength after hygrothermal cycles in accordance with 2.2.11.1.1.
- Bending strength in four-point test arrangement after hygrothermal cycles in accordance with 2.2.11.1.2.

2.2.11.1.1. Torque peel strength after hygrothermal cycles.

Assessment method

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.7. After hygrothermal cycles the test of torque peel strength (see 2.2.7) shall be performed and evaluated and average value of torque peel strength after hygrothermal cycles $T_{h,av}$ [N.m/m] calculated.

The relative change of torque peel strength after hygrothermal cycles, given in % in integer, shall be calculated according to equation:

$$\Delta_{T_h} = \frac{T_{h,av}}{T_{INI,av}} \times 100$$

The following defects shall be noted and recorded before, during and after all the tests:

- Delamination of individual layers of TMCS,

- Deterioration or cracking or breakage on TMCS.

Expression of results

The following characteristics related to hygrothermal behaviour on the TMCS shall be stated in the ETA:

- Option 1 or 2 of exposure to hygrothermal cycles.
- Average value of torque peel strength after hygrothermal cycles $T_{h,av}$ [N.m/m].
- Relative change of torque peel strength after hygrothermal cycles ΔT_h [%].
- Description of defects of test specimen, if occur during test of hygrothermal behaviour, or statement "Without defects".

2.2.11.1.2. Bending strength in four-point test arrangement after hygrothermal cycles

Assessment method

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.5.1. After hygrothermal cycles the test of bending strength in four-point test arrangement (see 2.2.5.1) shall be performed and evaluated and average value of bending strength in four-point test arrangement after hygrothermal cycles $R_{h,av}$ [MPa] calculated.

The relative change of bending strength in four-point test arrangement after hygrothermal cycles, given in % in integer, is to be calculated according to equation:

$$\Delta_{R_h} = \frac{R_{h,av}}{R_{bend,INI,av}} \times 100$$

Expression of results

The following characteristics related to hygrothermal behaviour on the TMCS shall be stated in the ETA:

- Option 1 or 2 of exposure to hygrothermal cycles.
- Average value of bending strength in four-point test arrangement after hygrothermal cycles $R_{h,av}$ [MPa].
- Relative change of bending strength in four-point test arrangement after hygrothermal cycles ΔR_h [%].
- Description of defects of test specimen, if occur during test of hygrothermal behaviour, or statement "Without defects".

2.2.11.2. Effect of immersion for 6 hours in boiling water at 90 °C

Purpose of the assessment

The purpose of the assessment is to provide short exposure to heat behaviour of TMCS by testing after exposure to 6 hours in boiling water at 90 ºC.

Ageing method

The effect of immersion for 6 hours in boiling water at 90 °C on the TMCS shall be determined by tests on 6 specimens per test, after being conditioned and exposed as described below:

Specimens shall be distanced each other at least 25 mm, placed horizontally over a perforated rack, with its front skin facing down, with water layer high above them of 3 to 50 mm.

In order to determine effects on core and adhesive layer of water vapour diffusion, specimens shall be fully immersed in boiling water[6] during 6 hours at 90 ºC.

This equipment shall be used (see figure 2.2.11):

- Containers of adequate volume able to storage different specimens.

[6] Although strictly speaking bowling point of water is at 100 ºC under normal atmospheric pressure, it is maintained this term due to its extended use for testing conditions of 90 ºC.

- Connector: Optional-socketed flat flanged lid used for connecting between flask and condenser.
- Condenser: To condense water vapour driven off by boiling to ensure a constant volume of water.
- Heater: An electric heating blanket or resistance providing uniform heating to the flask.
- Timer: A suitable device capable to measure duration.
- Thermometer: A suitable (accuracy ± 1 ºC) device capable to measure water's temperature.

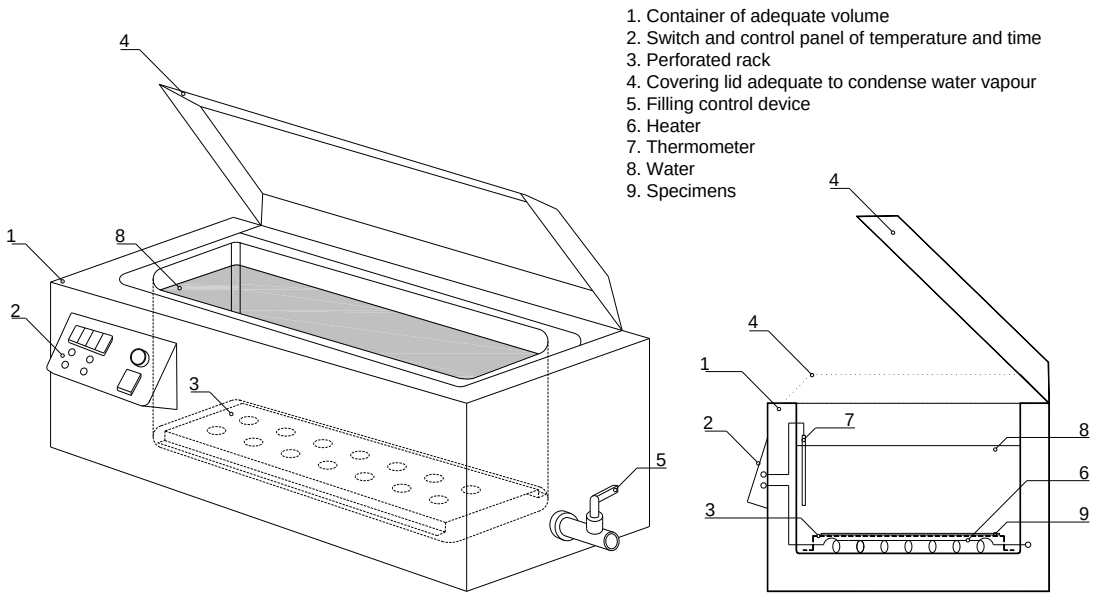


Figure 2.2.11: Schema of equipment for 6 h immersion in water 90 ºC

This procedure shall be followed:

- Fill container to 2/3 of its volume using tap water.
- Heat water to boiling using heating blanket.
- Add prepared specimens to water, start timer, connect condenser and start condenser.
- After six hours in water maintained at 90 °C, specimens shall be taken out and cooled in free air to ambient temperature (23 ± 2 °C) before further testing.

Then, the following tests shall be carried out:

- Torque peel strength after hygrothermal cycles in accordance with 2.2.11.2.1.
- Bending strength in four-point test arrangement in accordance with 2.2.11.2.2.

The following defects shall be noted and recorded before, during and after all the tests:

- Delamination of individual layers of TMCS.
- Deterioration or cracking or breakage on TMCS.

2.2.11.2.1. Torque peel strength after immersion of test specimens for 6 hours in boiling water at 90 °C

Assessment method

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.7. After immersion of test specimens for 6 hours in boiling water at 90 °C the test of torque peel strength (see 2.2.7) shall be performed and evaluated and average value of torque peel strength after immersion for 6 hours in boiling water at 90 °C $T_{i,6h,90°C,av}$ [N.m/m] calculated.

The relative change of torque peel strength after immersion for 6 hours in boiling water at 90 °C, given in % in integer, shall be calculated according to equation:

$$\Delta_{T_{i,6h,90\,℃}} = \frac{T_{i,6h,90\,℃,av}}{T_{INI,av}} \times 100$$

Expression of results

The following characteristics related to immersion for 6 hours in boiling water at 90 °C on the TMCS shall be stated in the ETA:

- Average value of torque peel strength after immersion for 6 hours in boiling water at 90 °C, $T_{i,6h,90°C,av}$ [N.m/m].
- Relative change of torque peel strength after immersion for 6 hours in boiling water at 90 °C, $\Delta T_{i,6h,90°C}$ [%].
- Description of defects of test specimen, if occur during test of effect of immersion for 6 hours in boiling water at 90 °C, or statement “Without defects”.

2.2.11.2.2. Bending strength in four-point test arrangement after immersion of test specimens for 6 hours in boiling water at 90 °C

Assessment method

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.5.1. After immersion for 6 hours in boiling water at 90 °C the test of bending strength in four-point test arrangement (see 2.2.5.1) shall be performed and evaluated and average value of bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C $R_{i,6h,90°C,av}$ [MPa] calculated.

The relative change of bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C, given in % in integer, is to be calculated according to equation:

$$\Delta_{R_{i,6h,90°C}} = \frac{R_{i,6h,90°C,av}}{R_{bend,INI,av}} \times 100$$

Expression of results

The following characteristics related to immersion for 6 hours in boiling water at 90 °C on the TMCS shall be stated in the ETA:

- Average value of bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C $R_{i,6h,90°C,av}$ [MPa].
- Relative change of bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C $\Delta R_{i,6h,90°C}$ [%].
- Description of defects of test specimen, if occur during test of effect of immersion for 6 hours in boiling water at 90 °C, or statement “Without defects”.

2.2.11.3. Effect of immersion for 500 hours in water at 20 °C

Purpose of the assessment

The purpose of the assessment is to provide exposure to water behaviour of TMCS by testing after immersion along 500 hours in water at 20º C.

Ageing method

The effect of immersion for 500 hours in water at 20 (± 3) °C on the TMCS shall be determined by tests on 6 specimens per test, after being conditioned and exposed as described below:

In order to determine effects of liquid water on core and adhesive layer, specimens shall be fully immersed along 500 h at 20 (± 3) °C uninterruptedly. Specimens shall be distanced each other at least 25 mm, placed horizontally over a perforated rack, and with its front skin facing down, with water layer high above them of at least 5 to 10 mm.

This equipment shall be used:

- Containers of adequate volume able to storage different specimens, capable to avoid water evaporation.
- Thermometer: A suitable (accuracy ± 1 ºC) device capable of measuring temperature of water.

This procedure shall be followed:

- Immerse specimens in tap water at 20 (± 3) °C
- After the exposure period, remove water from sample before further testing.

Then, the following tests shall be carried out:

- Torque peel strength after immersion for 500 hours in water at 20 °C in accordance with 2.2.11.3.1.
- Bending strength in four-point test arrangement after immersion for 500 hours in water at 20 °C in accordance with 2.2.11.3.2.

The following defects shall be noted and recorded before, during and after the all tests:

- Delamination of individual layers of TMCS.
- Deterioration or cracking or breakage on TMCS.

2.2.11.3.1. Torque peel strength after immersion for 500 hours in water at 20 °C

Assessment method

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.7. After immersion of test specimens for 500 hours in water at 20 (± 3) °C the test of torque peel strength (see 2.2.7) is to be performed and evaluated and average value of torque peel strength after immersion for 500 hours in water at 20 °C $T_{i,500h,20°C,av}$ [N.m/m] calculated.

The relative change of torque peel strength after immersion for 500 hours in water at 20 °C, given in % in integer, is to be calculated according to equation:

$$\Delta_{T_{i,500h,20\,℃}} = \frac{T_{i,500h,20\,℃,av}}{T_{INI,av}} \times 100$$

Expression of results

The following characteristics related to immersion for 500 hours in water at 20 (± 3) °C of the TMCS shall be stated in the ETA:

- Average value of torque peel strength after immersion for 500 hours in water at 20 °C, $T_{i,500h,20°C,av}$ [N.mm/mm].
- Relative change of torque peel strength after immersion for 500 hours in water at 20 °C, $\Delta T_{i,500h,20°C}$ [%].
- Description of defects of test specimen, if occur during test of effect of immersion for 500 hours in water at 20 °C, or statement “Without defects “.

2.2.11.3.2. Bending strength in four-point test arrangement after immersion for 500 hours in water at 20 °C

Assessment method

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.5.1. After immersion for 500 hours in water at 20 °C the test of bending strength in four-point test arrangement (see 2.2.5.1) shall be performed and evaluated and average value of bending strength in four-point test arrangement after immersion for 500 hours in water at 20 °C $R_{i,500h,20°C,av}$ [MPa] calculated.

The relative change of bending strength in four-point test arrangement after immersion for 500 hours in water at 20 °C, given in % in integer, shall be calculated according to equation:

$$\Delta_{R_{i,500h,20°C}} = \frac{R_{i,500h,20°C,av}}{R_{bend,INI,av}} \times 100$$

Expression of results

The following characteristics related to immersion for 500 hours in water at 20 (± 3) °C of the TMCS shall be stated in the ETA:

- Average value of bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C $R_{i,6h,90°C,av}$ [MPa].

- Relative change of bending strength in four-point test arrangement after immersion for 6 hours in boiling water at 90 °C $\Delta R_{i,6h,90°C}$ [%].
- Description of defects of test specimen, if occur during test of effect of immersion for 6 hours in boiling water at 90 °C, or statement “Without defects”.

2.2.11.4. Effect of freeze-thaw cycles

Purpose of the assessment

The purpose of the assessment is to provide freeze-thaw behaviour of TMCS by testing after exposure to 50 freeze-thaw cycles.

Ageing method

The effect of freeze – thaw cycles on the TMCS shall be determined by tests on 6 specimens per test, after being conditioned and exposed as described below:

Specimens shall be distanced each other at least 25 mm, placed horizontally with its front skin facing down and not touching chambers walls, over perforated racks, with water layer high above them of at least 5 to 10 mm, during the full immersion steps.

50 freeze-thaw cycles shall be carried out.

The following equipment shall be used:

- Freeze-thaw chamber with internal dimensions able to contain different sizes of specimens and to carry out steps and ranges of temperatures described at the procedure below.
- Racks / shelves: To support the test sample and enabling a uniform exposition with dimensions to fix the test specimens.

The following procedure has to be followed:

Each cycle shall be composed of:

- Full immersion of specimens in tap water bath for 8 h, at initial temperature of 20 (± 2) °C.
- Decrease to -20 (± 2) °C for 2 h (in conditioned air).
- Exposure to - 20 (± 2) °C (in conditioned air) for 14 h.

In case of interruption, specimens shall always be positioned in water between the cycles. Specified temperatures shall be measured at specimen surface.

For TMCS which are produced in more than one thickness, the tests shall be conducted with twelve samples from TMCS of maximum and minimum thickness (six per one thickness). The worst result shall apply to TMCS of all thicknesses.

Then, the following tests shall be carried out:

- Torque peel strength after 50 freeze – thaw cycles in accordance with 2.2.11.4.1.
- Bending strength in four-point test arrangement after 50 freeze – thaw cycles in accordance with 2.2.11.4.2.

The following defects shall be noted and recorded before, during and after all the tests:

- Delamination of individual layers of TMCS.
- Deterioration or cracking or breakage on TMCS.

2.2.11.4.1. Torque peel strength after 50 freeze – thaw cycles

Assessment procedure

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.7. After cycling of test specimens for 50 cycles, the test of torque peel strength (see 2.2.7) shall be performed and evaluated and average value of torque peel strength freeze – thaw cycles $T_{f/t,av}$ [N.m/m] calculated.

The relative change of torque peel strength after 50 freeze – thaw cycles, given in % in integer, shall be calculated according to equation:

$$\Delta_{T_{f/t}} = \frac{T_{\frac{f}{t},av}}{T_{INI,av}} \times 100$$

Expressions of results

The following characteristics related to effect of freeze - thaw cycles on the TMCS shall be stated in the ETA:

- Average value of torque peel strength after 50 freeze – thaw cycles $T_{f/t,av}$ [N.m/m].
- Relative change of torque peel strength after 50 freeze – thaw cycles $\Delta T_{f/t}$ [%].
- Description of defects of test specimen, if occur during test of effect of freeze – thaw cycles, or statement “Without defects".

2.2.11.4.2. Bending strength in four-point test arrangement after 50 freeze – thaw cycles

Assessment procedure

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.5.1. After 50 freeze – thaw cycles the test of bending strength in four-point test arrangement (see 2.2.5.1) shall be performed and evaluated and average value of bending strength in four-point test arrangement after freeze – thaw cycles $R_{f/t,av}$ [MPa] calculated.

The relative change of bending strength in four-point test arrangement after 50 freeze – thaw cycles, given in % in integer, shall be calculated according to equation:

$$\Delta_{R_{f/t}} = \frac{R_{f/t,av}}{R_{bend,INI,av}} \times 100$$

Expression of results

The following characteristics related to effect of freeze - thaw cycles on the TMCS shall be stated in the ETA:

- Average value of bending strength in four-point test arrangement after 50 freeze – thaw cycles $R_{f/t,av}$ [MPa].
- Relative change of bending strength in four-point test arrangement after 50 freeze – thaw cycles $\Delta R_{f/t}$ [%].
- Description of defects of test specimen, if occur during test of effect of freeze – thaw cycles, or statement “Without defects".

2.2.11.5. Effect of long-term exposure to heat (2500 hours at hot dry air 80 °C)

Purpose of the assessment

The purpose of the assessment is to provide long term exposure to heat behaviour of TMCS.

Ageing method

The effect of long-term exposure to heat shall be determined by tests on 6 specimens per test, after being exposed as described below:

Specimens shall be exposed to hot dry air at 80 (±2ºC) uninterruptedly for 2500 hours.

The following equipment shall be used:

- Oven: With forced air circulation and with temperature regulation to a range of 50 to 100ºC (± 2ºC). The internal dimensions are such to contain the different sizes of specimens.
- Shelves: To support the test sample and enabling a uniform heating with dimensions to fix the test specimen.

The following procedure has to be followed:

- Bring the oven to the required temperature.
- Place the test specimen on its supporting frame in the oven.
- Maintain the required temperature during the specified period of time.
- After the exposure period remove the sample from the oven, bring it back to ambient temperature (23 ± 2 ºC) and maintain it at that temperature for 24 hours before further testing.

The effect of long-term exposure after being conditioned and exposed to heat (2500 hours at hot dry air 80 °C) on the TMCS shall be determined by tests on specimens as described below:

- Torque peel strength after 2500 hours at 80 °C dry air in accordance with 2.2.11.5.1.
- Bending strength in four-point test arrangement after 2500 hours at 80 °C dry air in accordance with 2.2.11.5.2.

The following defects shall be noted and recorded before, during and after all the tests:

- Delamination of individual layers of TMCS.
- Deterioration or cracking or breakage on TMCS.

The following characteristics related to effect of long-term exposure to heat (2500 hours at hot dry air 80 °C) on the TMCS shall be stated in the ETA:

- Average value of torque peel strength after exposure to heat for 2500 hours at hot dry air 80 °C $T_{lt,80℃,av}$ [N.m/m] and of bending strength in four-point test arrangement after exposure to heat for 2500 hours at hot dry air 80 °C $R_{lt,80℃,av}$ [MPa].
- Relative change of torque peel strength after exposure to heat for 2500 hours at hot dry air 80 °C $\Delta T_{lt,80℃}$ [%] and relative change of bending strength in four-point test arrangement after exposure to heat for 2500 hours at hot dry air 80 °C $\Delta R_{lt,80℃}$ [%].
- Description of defects of test specimen, if occur during test of effect of 2500 h at 80ºC, or statement “Without defects”.

2.2.11.5.1. Torque peel strength after 2500 hours at 80 °C dry air

Assessment procedure

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.7. After ageing of test specimens for 2500 hours at hot dry air 80 °C, the test of peel–force (see 2.2.7) shall be performed and evaluated and average value of torque peel strength after exposure to heat for 2500 hours at hot dry air 80 °C $T_{lt,80℃,av}$ [N.m/m] calculated.

The relative change of torque peel strength after exposure to heat for 2500 hours at hot dry air 80 °C, given in % in integer, shall be calculated according to equation:

$$\Delta T_{F_{lt,80℃}} = \frac{T_{lt,80℃,av}}{T_{INI,av}} \times 100$$

Expression of results

The following characteristics related to effect of long-term exposure to heat (2500 hours at hot dry air 80 °C) on the TMCS shall be stated in the ETA:

- Average value of torque peel strength after exposure to heat for 2500 hours at hot dry air 80 °C, $T_{lt,80℃,av}$ [N.m/m].
- Relative change of torque peel strength after exposure to heat for 2500 hours at hot dry air 80 °C, $\Delta T_{lt,80℃}$ [%].
- Description of defects of test specimen, if occur during test of effect of 2500 h at 80ºC, or statement “Without defects”.

2.2.11.5.2. Bending strength in four-point test arrangement after 2500 hours at 80 °C dry air

Assessment procedure

The test shall be performed on six conditioned test specimens by testing in accordance with 2.2.5.1. After ageing of test specimens for 2500 hours at hot dry air 80ºC, the test of bending strength in four-point test arrangement (see 2.2.5.1) shall be performed and evaluated, and average value of bending strength in four-point test arrangement after ageing for 2500 hours at hot dry air 80ºC $R_{lt,80ºC,av}$ [MPa] calculated.

The relative change of bending strength in four-point test arrangement after ageing for 2500 hours at hot dry air 80ºC, given in % in integer, shall be calculated according to equation:

$$\Delta_{R_{lt,80\,℃}} = \frac{R_{lt,80\,℃,av}}{R_{bend,INI,av}} \times 100$$

Expression of results

The following characteristics related to effect of long-term exposure to heat (2500 hours at hot dry air 80 °C) on the TMCS shall be stated in the ETA:

- Average value of bending strength in four-point test arrangement after exposure to heat for 2500 hours at hot dry air 80 °C $R_{lt,80℃,av}$ [MPa].
- Relative change of bending strength in four-point test arrangement after exposure to heat for 2500 hours at hot dry air 80 °C $\Delta R_{lt,80℃}$ [%].
- Description of defects of test specimen, if occur during test of effect of 2500 h at 80ºC, or statement “Without defects”.

2.2.11.6. Creep test

The creep behaviour of the TMCS shall be determined on three test specimens per type of thickness of TMCS, and at least on specimens of maximal and minimal product thickness. The test procedure shall be carried out in accordance with Annex G.

The creep coefficient φt [-], the applied load F [in N], and the span considered in the test in accordance with Annex G shall be indicated in the ETA.

3. ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1. System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD with regard to intended use as internal and external wall and ceiling finishes the applicable European legal act is Decision 98/437/EC as amended by Decision 2001/596/EC:

- The system is **3.**

In addition, with regard to reaction to fire for products covered by this EAD, the applicable European legal act is Decision 1998/437/EC as amended by Decision 2001/596/EC:

- The systems are: **1, 3, 4.**

For the products covered by this EAD with regard to their intended use for manufacturing of elements for kits for exterior wall claddings the applicable European legal act is Decision 2003/640/EC:

- The system is: **2+.**

In addition, with regard to reaction to fire for products covered by this EAD the applicable European legal act is Decision 2003/640/EC.

- The systems are: **1, 3, 4.**

3.2. Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.2.1.

Table 3.2.1. Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of specimens	Minimum frequency of control
Factory production control (FPC)					
1	Reaction to fire (i)				
	Reaction to fire (for any classification)	Indirect tests as specified in table 3.2.1(cornerstones n.3, 4, 6 and 7)	See table 3.2.1 (corner-stones n.3, 4, 6 and 7)	See table 3.2.1 (cornerstones n.3, 4, 6 and 7)	See table3.2.1 (cornerstones n.3, 4, 6 and 7)
	Reaction to fire (for class A1)	Direct test in accordance with EN ISO 1182	As defined in the Control Plan	According to test method and the Control Plan (iv)	(iii)
	Reaction to fire (for class A1 or A2)	Direct test in accordance with EN ISO 1716	As defined in the Control Plan	According to test method and the Control Plan (iv)	At least once each two years
	Reaction to fire (for class A2 to D)	Direct test in accordance with EN 13823 (ii)	As defined in the Control Plan	According to test method and the Control Plan (iv)	(iii)
	Reaction to fire (for class E and F)	Direct test in accordance with EN ISO 11925-2	As defined in the Control Plan	According to test method and the Control Plan (iv)	(iii)

(i) Indirect tests shall be applied to all components independently from the source of their classification (Testing, Decision 1998/437/EC as amended by Decision 2001/596/EC, or any other applicable CWFT decision). Direct tests within the FPC shall only apply to those components where the classification is based on the prescribed tests for the corresponding class(es) in accordance with Commission Delegated Regulation (EU) 2016/364 and EN 13501-1.

(ii) If it is necessary to perform SBI tests within the FPC, that test set-up shall be used which was used as worst case for the classification tests within the ETA procedure.

(iii) The tests shall always be carried out whenever the performance is not verified by means of indirect tests (see table 3.2.1) or, at least, once each five years when the indirect tests verify the performance. For this minimum frequency, the sufficient correlation between the foreseen system of indirect FPC measures and the direct tests shall be stated in the Control Plan. Otherwise, the minimum frequency of direct tests within the FPC shall be at least once per two years.

(iv) The necessary number of specimens shall be more detailed in the control plan depending on the test method and the class to be verified within the FPC. The tests shall be performed on randomly taken samples from the consecutive production process.

Table 3.2.1 (continuation). Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of specimens	Minimum frequency of control
Factory production control (FPC)					
Incoming materials					
2	Receipt materials	Checking of delivery ticket or label on the package	Conformity with the order	---	Each delivery
		Checking of supplier certificates or supplier tests	Conformity with the order	---	Each delivery
Process					
3	When relevant, flame retardant quantity (i)	Quantity measurement	As defined in the Control Plan	---	Each batch
Finished TMCS					
4	Geometry (form and dimensions) (i)	When apply, as defined in the relevant hEN or EAD Otherwise measuring, visual check	As defined in the Control Plan	As defined in the Control Plan	Daily(ii)
5	Apparent area density	EN ISO 29470, cl. 7. Specimens previously conditioned in accordance with Clause 6.4	As defined in the Control Plan	As defined in the Control Plan	Daily (ii)
6	PCS value (for class B to D) (i)	Test in accordance with EN ISO 1716	As defined in the Control Plan	As defined in the Control Plan	Monthly (ii)
7	Organic content (i)	Ash content / loss on For products which are inorganic, i.e. products containing a low percentage of organic compounds, the test method shall be based on EN 13820. For products which are organic, the test method shall be based on EN ISO 3451-1. Otherwise, Thermogravimetry test based on EN ISO 11358-1	As defined in the Control Plan	As defined in the Control Plan	Once per batch (ii)
8	Tensile performance				
	Core included: • Tensile strength • Yield strength • Elongation • Modulus of elasticity	2.2.3.	As defined in the Control Plan	5	1 per year
	Without core: • Tensile strength • Yield strength • Elongation				
9	Tensile strength perpendicular to the face	2.2.4	As defined in the Control Plan	5	1 per year
10	Flexural performance				
	• Bending strength in four-point test arrangement	2.2.5	As defined in the Control Plan	5	At modification

	• Bending modulus of elasticity in four-point test arrangement • Flexural strength in three-point test arrangement					of product or material used
11	Shear performance					
	• Shear strength • Modulus of elasticity	2.2.6		As defined in the Control Plan	5	At modification of product or material used
12	Thickness	Total thickness	Method A ISO 23529, Clause 9.1 Median: ISO 3534-1, Clause 1.13	As defined in the Control Plan	5	1 per day
	• Total thickness of TMCS • Thickness of skin	Skin thickness	EN 485-1, Clause 6.7 Median: ISO 3534-1, Clause 1.13			
13	Torque peel strength	2.2.9		As defined in the Control Plan	6	1 per year
14	Hard body impact resistance	2.2.10		As defined in the Control Plan	3	At modification of product process or material used
15	Dynamic stiffness	2.2.11		As defined in the Control Plan	3	At modification of product process or material used
16	Coefficient of thermal conductivity	2.2.12		As defined in the Control Plan	1	At modification of product process or material used
17	Durability					
	• Hygrothermal behaviour	2.2.13.1		As defined in the Control Plan	6	At modification of product process or material used
	• Effect of immersion for 6 hours in boiling water at 90 °C	2.2.13.2			6	
	• Effect of immersion for 500 hours in water at 20 °C	2.2.13.3			6	
	• Effect of freeze-thaw cycles	2.2.13.4			6	
	• Effect of long-term exposure to heat (2500 hours at hot dry air 80 °C)	2.2.13.5			6	
	• Creep test	2.2.13.6			1	

(i) Indirect characteristic related to reaction to fire
(ii) (Deviations from the given cornerstones (higher or lower frequencies) may be agreed between manufacturer and TAB and laid down in the Control Plan case by case depending on the type of production process, the variation in the volume produced and the production process control.

3.3. Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 3.3.1.

Table 3.3.1. Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control *(for system 2+ only)*					
1	Notified Body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the TMCS	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	According to Control plan	According to Control plan	when starting the production, after its modification or when starting a new production line
2	Control of the manufacturing plant and of the factory production carried out by the manufacturer regarding the constancy of performance related to essential characteristics (excluding reaction to fire) under the Basic Works Requirements 4, 5 and 6 taking into account the use for manufacturing of elements for kits for exterior wall claddings	As defined in Clauses 2.2.3 to 2.2.13 of the EAD	According to Control plan	According to Control plan	when starting the production, after its modification or when starting a new production line
Continuous surveillance, assessment and evaluation of factory production control *(for system 2+ only)*					
3	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	According to Control plan	According to Control plan	1 per year
4	Continuous surveillance, assessment and evaluation of the factory production carried out by the manufacturer regarding the constancy of performance related to essential characteristics (excluding reaction to fire) under the Basic Works Requirements 4, 5 and 6 taking into account the use for manufacturing of elements for kits for exterior wall claddings	As defined in Clauses 2.2.3 to 2.2.13 of the EAD	According to Control plan	According to Control plan	1 per year

The intervention of the notified body under AVCP system 1 is only necessary for reaction to fire for products/materials for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g., an addition of fire retardants or a limiting of organic material).

In this case the cornerstones of the tasks to be undertaken by the notified body under AVCP system 1 are laid down in Table 3.3.2.

Table 3.3.2. Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire. *(for system 1 only)*					
1	Control of the manufacturing plant and of the factory production carried out by the manufacturer regarding the constancy of performance related to reaction to fire and taking into account a limiting of organic material and/or the addition of fire retardant.	As defined in Clause 2.2.1 of the EAD	According to Control plan	According to Control plan	when starting the production, after its modification or when starting a new production line
Continuous surveillance, assessment and evaluation of factory production control carried out by the manufacturer regarding the constancy of performance related to reaction to fire *(for system 1 only)*					
2	Where the intervention of the Notified Body is necessary only because the conditions for the applicability of system 1 in the Decisions regarding reaction to fire are fulfilled, the notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material)	As defined in Clause 2.2.1 of EAD	As defined in the control plan agreed between the TAB and the manufacturer	As defined in the control plan agreed between the TAB and the manufacturer	1/year

4. REFERENCE DOCUMENTS

EAD 090062-00-0404	Kits for external wall claddings mechanically fixed
EN 485-1:2016	Aluminium and aluminium alloys – Sheet, strip and plate – Part 1: Technical conditions for inspection and delivery
EN 485-2:2016+A1:2018	Aluminium and aluminium alloys - Sheet, strip and plate - Part 2: Mechanical properties
EN 485-4:1993	Aluminium and aluminium alloys. Sheets, strip and plate. Part 4: Tolerances on shape and dimensions for cold-rolled products
EN 1396:2015	Aluminium and aluminium alloys - Coil coated sheet and strip for general applications – Specifications
EN1990:2002/A1:2005/AC:2010	Eurocode - Basis of structural design
EN 10088-1:2014	Stainless steels - Part 1: List of stainless steels
EN 10088-2:2014	Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes
EN 12090:2013	Thermal insulating products for building applications - Determination of shear behaviour
EN 12467: 2012+A2:2018	Fibre-cement flat sheets - Product specification and test methods
EN 12664:2001	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Dry and moist products of medium and low thermal resistance
EN 13238:2010	Reaction to fire tests for building products - Conditioning procedures and general rules for selection of substrates
EN 13501-1:2018	Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests
EN 13820:2003	Thermal insulating materials for building applications - Determination of organic content
EN 13823:2020	Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item
EN 14509:2013	Self-supporting double skin metal faced insulating panels - Factory made products – Specifications
EN 16516:2017+A1:2020	Construction products: Assessment of release of dangerous substances - Determination of emissions of into indoor air
EN 16637-2:2023	Construction products: Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test
EN ISO 291:2008	Plastics – Standard atmospheres for conditioning and testing (ISO 291:2008)
EN ISO 527-1:2019	Plastics – Determination of tensile properties – Part 1: General principles (ISO 527-1:2019)
EN ISO 527-2:2012	Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:2012)
EN ISO 1716:2018	Reaction to fire tests for products - Determination of the gross heat of combustion (calorific value) (ISO 1716:2018).
EN ISO 1182:2020	Reaction to fire tests for products - Non-combustibility test (ISO 1182:2020).
EN ISO 3451-1:2019	Plastics - Determination of ash - Part 1: General methods (ISO 3451-1:2019)
EN ISO 6341:2012	Water quality - Determination of the inhibition of the mobility of Daphnia magna Straus (Cladocera, Crustacea) - Acute toxicity test (ISO 6341:2012)
EN ISO 7599:2018	Anodizing of aluminium and its alloys - General specifications for anodic oxidation coatings on aluminium (ISO 7599:2018)
EN ISO 11348-1:2008/A1:2018	Water quality - Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test) - Part 1: Method using freshly prepared bacteria - Amendment 1 (ISO 11348-1:2007/Amd 1:2018)
EN ISO 11348-2:2008/A1:2018	Water quality - Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test) - Part 2: Method using liquid-dried bacteria - Amendment 1 (ISO 11348-2:2007/Amd 1:2018)
EN ISO 11348-3:2008/A1:2018	Water quality - Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test) - Part 3: Method using freeze-dried bacteria - Amendment 1 (ISO 11348-3:2007/Amd 1:2018)
EN ISO 11358-1:2022	Plastics - Thermogravimetry (TG) of polymers - Part 1: General principles (ISO 11358-1:2022)
EN ISO 11925-2:2020	Reaction to fire tests - Ignitability of building products subjected to direct impingement of flame - Part 2: Single-flame source test (ISO 11925-2:2020)
EN ISO 16012:2015	Plastics - Determination of linear dimensions of test specimens (ISO 16012:2015)
EN ISO 29470:2020	Thermal insulating products for building applications - Determination of the apparent density. (ISO 29470:2020)
ISO 2602:1980	Statistical interpretation of test results. Estimation of the mean. Confidence interval
ISO 3534-1:2006	Statistics - Vocabulary and symbols - Part 1: General statistical terms and terms used in probability
ISO 7892:1988	Vertical building elements -- Impact resistance tests -- Impact bodies and general test procedures
ISO 9052-1:1989	Acoustic – Determination of dynamic stiffness – Part 1: Materials used under floating floors in dwellings
ISO 23529:2016	Rubber - General procedures for preparing and conditioning test pieces for physical test methods

ANNEX A REACTION TO FIRE – MOUNTING AND FIXING CONDITIONS

A.1. EN 13823

This method is relevant for classes A2, B, C and D (in some cases also for A1).

A.1.1. Mounting

Products that are free standing in their end use application shall be tested free standing at a distance of at least 80 mm from the backing board.

Products that in their end use application are directly fixed to a substrate shall be tested fixed as used in end use (mechanically, glued) to a substrate. Standard substrates shall meet the requirements of EN 13238.

Products that have in the end use application an air gap or a ventilated cavity behind, it shall be tested with the minimum air gap depth as defined by the manufacturer and allowed by the subframe dimensions and geometry (but not less than 20 mm recommended) and a 40 mm air gap depth between rear side of the product and the substrate). Both distances have to be tested and the worst indicative test shall be considered for classification. The product shall be mounted on a wooden or metallic substructure, nailed or screwed together.

For products with a ventilated air gap behind, there shall be a gap of 10 mm between the bottom of the specimen and top level of U-profile of the SBI-test device, except in cases where air can flow into the air gap from the outer, lateral edges of the specimen wings (e. g. when using punctually positioned subframe devices) or in case of products with a non-ventilated air gap. The space between test rig backing board and backside of the supporting frame can be filled optionally with mineral wool insulation with a nominal thickness of 50 mm, a nominal density of (70 ± 20) kg/m³ and a class A2-s1, d0 in accordance with EN 13501-1. The thermal insulation is imprisoned between the frames and the test rig backing board.

A.1.2. Joints

Product applied with horizontal and/or vertical joints shall be tested with a horizontal joint in the long wing at a height of 500 mm from the bottom edge of the specimen and/or with a vertical joint in the long wing at a distance of 200 mm from the corner line, measured when the wings are mounted ready for testing. The maximum opening width has to be tested.

A.1.3. Product orientation

Products with identical surface finishes on both sides have to be tested at one side only. Products with different surface finishes or coatings on different sides shall be tested on both sides or with the side representative for the worst performance directed to the fire. The worst performance is normally obtained with the side having the finish with the highest organic content per m² surface. The side with the highest organic content shall be derived from the composition of the different finishing layers or by determining their gross calorific value in accordance with EN ISO 1716, taking account of the respective applied dry weights of the finishing layers.

In addition, the influence of different colours shall be considered by performing tests on a light, on a dark and on a colour in the middle of the range (e.g., CIELAB 40.51, 59.28, 47.98; RGB 184, 29, 19; Munsell ref. 7.5R 4/13; RAL 3020; or BS04E56).

A.1.4. Field of application for the obtained classification

The results of tests are valid for products:

- With the same formulation of the same type, but with different dimensions of length and width.
- With a density range between the highest and lowest density tested.
- With a thickness range between the highest and lowest thickness tested.
- With a joint opening width equal to or smaller than those used for the test.

- Fixed with all other types of mechanical devices such as metal nails or rivets.
- The same or higher amount of the same type of flame retardants.
- The weight per unit area as tested or the range between highest and lowest value evaluated in the tests.
- Each tested adhesive with equal or lower coverages than tested.
- Products tested on wooden frames can also be used on metallic profiles.
- Products tested on frames made of aluminum profiles can only be used on subframes made of aluminum or aluminum alloy with a melting temperature range above at least 500 °C.
- Products tested on a frame made of steel profiles can only be used on subframes made of metal profiles with a melting temperature range above at least 1000 °C.
- With a different surface texture (smooth or embossed).
- Fixed at different (wider or closer) horizontal or vertical fixing centres.
- Without thermal insulation in the cavity or with other types of class A2-s1,d0 in accordance with EN 13501-1 insulation materials as long as a ventilated air gap of at least (40±1) mm directly behind the sheets is present.
- Without thermal insulation in the cavity or with other insulation materials of class A1 or A2-s1,d0 in accordance with EN 13501-1 with a higher density than those used in the test set-up.
- Without finishes or with different finishes or coatings (e.g., different colours) as long as the test was performed considering the worst case as explained in A.1.3.
- In cases where Ethylene Propylene Diene Monomer, hereafter EPDM, jointing strip has been used the result is also valid for EPDM jointing strip material or other jointing material with the same or higher fire classification.

The results of tests are valid for:

- The tested chemical composition.
- Tested surface structures.
- Tested range of colours.
- Any thickness between those tested.
- Any weight per unit areas between those tested.
- Any orientation.
- Either each tested adhesive with equal or lower coverages than tested.

A.2. EN ISO 11925-2

This test method is relevant for classes B, C, D, E and F.

The product shall be tested free standing and with surface exposure and edge exposure. An additional set of tests shall be carried out with the specimen turned at 90° round its vertical axis and the flame impinging at the bottom edge of the centreline of the underside of each different layer.

The following parameters shall be considered when preparing the test specimens:

- Chemical composition: each different composition of core, face material and coating material.
- Colour: if there is a range of different colours, tests with a light, a dark and a medium colour (e.g., white, black and red) shall be performed.
- Thickness: highest and lowest thickness.
- Density/weight per unit area: the highest and the lowest density/weight per unit area.
- Orientation: if relevant, the specimen shall be mounted and tested with vertical and with horizontal orientation.
- Amount of organic content as well as type and amount of flame retardants.

At least two tests with any of the identified specimen configurations (based on the aforementioned parameters) shall be performed and four further tests with the most onerous specimen configuration as basis for the classification. The results of tests are valid for:

- Only the chemical composition of core and assembly of TMCS as tested.
- Tested range of colours.
- Any thickness between those tested.
- Any weight per unit areas between those tested.
- Any orientation.
- Equal or lower amount of organic content as well as higher amount of flame retardants.

A.3. EN ISO 1716

This test method is relevant for classes A1 and A2 only.

The test is to be performed on each component of TMCS separately, except of components classified as A1 without testing and/or metallic components (see EN ISO 1716, Clause 7.1 and 9.4.1).

The number and preparation of test specimens are given in EN ISO 1716, Clause 7. Components used in TMCS in form of thin film (e.g., adhesive, coating) manufacturer provides for test in fresh form. These components shall be applied in test laboratory in appropriate thickness to inert substrate to hard in form of film for procedure of preparation of test specimen in accordance with EN ISO 1716, Clause 7.2.4.

For components addressed in the 2nd paragraph which do not need to be tested, their PCS value is set as zero for further calculation of the total PCS value of the TMCS.

The gross heat of combustion is to be determined in accordance with EN ISO 1716, Clause 8, and calculated in accordance with EN ISO 1716, Clause 9.

Parameters relevant for this test method are:

- Composition (when performing calculation of the Q_{PCS}-value).
- Density or mass per unit area.
- Thickness.

A.4. EN ISO 1182

This test method is relevant for classes A1 and A2 only. The test is to be performed for the ‘substantial components’ of the product as given in EN 13501-1, Clause 3.1.5, only.

The non-combustibility test shall be performed in accordance with EN ISO 1182, Clause 7. The preparation and number of test specimens are given in EN ISO 1182, Clause 5.

The test result shall be calculated and expressed in accordance with EN ISO 1182, Clause 8.

Parameters relevant for this test method are:

- Composition - each different one shall be tested.
- Density or mass per unit area - the highest and lowest value shall be tested.
- Thickness - relevant for the decision whether a component is substantial and therefore needs to be tested.
- Type and amount of flame retardant (if used) - each different type with the lowest amount shall be considered within the tests.

ANNEX B TENSILE STRENGTH PERPENDICULAR TO THE FACE

The test of tensile strength perpendicular to the face shall be carried out in accordance with the following test procedure on 5 test specimens at least.

Test specimens of circular shape of diameter (50 ± 0.3) mm shall be cut from TMCS by water jet cutting machine. The two circular metal stamps (targets) of appropriate size shall be affixed centrically to both sides of test sample with suitable adhesive.

Test specimen shall be affixed through metal plates into clamps of test machine and test load to destruction shall be inserted.

The test speed shall be adjusted to 5 mm/min. The maximal force in destruction F_m [N] and mode of destruction shall be registered, force with accuracy in integer.

Tensile strength perpendicular to the face σ_{mt} [MPa] shall be calculated as:

$$\sigma mt = FmA = 4 \times Fm\pi \times d2$$

where is

F_m	maximal tension force in N.
A	sectional area of test specimen in mm^2.
d	diameter of test specimen in mm.

The single calculated values shall be rounded to two significant digits.

The test report shall contain at least characteristics mentioned below:

- Description of test specimen (total nominal thickness of TMCS, material and nominal thickness of faced skins, material of core composition).
- Each tested values of diameter of test specimens, related force in failure determined by test of tensile strength perpendicular to the face, description of failure mode, single values of calculated tensile strength perpendicular to face, their average value and estimation of standard deviation.

ANNEX C SHEAR PERFORMANCE

The test of shear strength and shear modulus of elasticity shall be carried out in accordance with the following test procedure on five test specimens at least.

Test specimens of rectangle shape of dimensions 120 x 50 mm shall be cut from TMCS by water jet cutting machine. Then they shall be adjusted by milling cutter to the shape given on Figure D.1.

The two metal plates of appropriate size shall be affixed to both sides of test sample with suitable adhesive (see Figure D.2).

Test specimen shall be affixed through metal plates into clamps of test machine and test load to destruction shall be inserted. Working diagram deformation / test load shall be recorded from movement of clamps.

The test speed shall be adjusted to 1 mm/min. The maximal force in failure F_m [N] and mode of destruction shall be registered, force with accuracy in integer.

Shear strength and shear modulus of elasticity shall be calculated and expressed as follows:

- Shear strength σ_s in accordance with EN 12090, Cl 8.2, in MPa.
- Shear modulus of elasticity G in accordance with EN 12090, Clause 8.3, in MPa.

The single calculated values shall be rounded to three significant digits.

The test report shall contain at least characteristics mentioned below:

- Description of test specimen (nominal thickness of TMCS, material and nominal thickness of faced skins, material of core composition).
- Each tested values of dimensions of test specimens, related force in failure determined by test of shear strength, description of failure mode, single values of calculated shear strength, their average value and estimation of standard deviation.

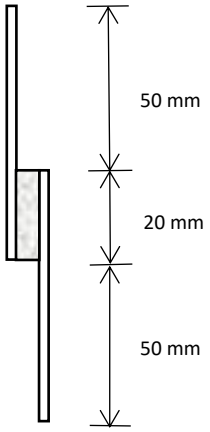


Figure C.1. Test specimen

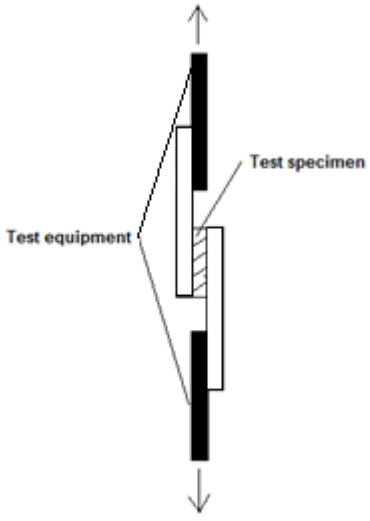


Figure C.2. Test assembly

ANNEX D TORQUE PEEL STRENGTH

D.1 - Delamination resistance by peeling test (torque peel strength test)

Peeling tests shall be carried out following procedure described below. Delamination resistance is a fundamental parameter for the assessment of deterioration of sheets in comparative terms, and the results are not intended to be used for calculations.

D.1.1 - Preparation and conditioning of specimens

Couples of specimens named as “a” and “b”, shall be taken from left, central and right side of sheets cut in perpendicular sense of lamination. Preparation of specimens for test has to be done according to manufacturer product installation instructions (MPII). For each sheet thickness it shall be prepared a set of 6 specimens for initial state, and for assessment of durability, another 6 units shall be prepared for each ageing exposure.

3 specimens “a” of each set shall be subjected to front metallic skin - core peeling test and 3 specimens “b” to rear metallic skin – core peeling tests. Specimens shall be length x width = 300 ± 5 mm x 75 ± 1 mm. (See Figure D.1)

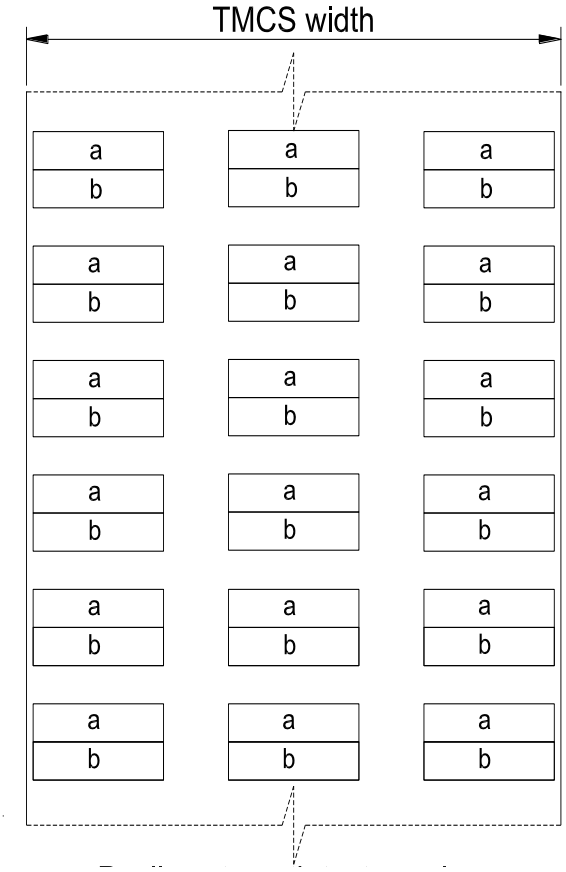


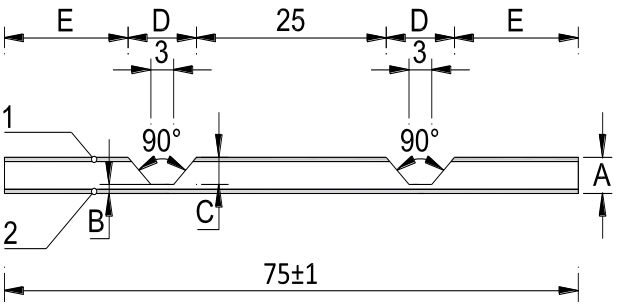
Figure D.1.Scheme of sampling on TMCS for specimens a and b (plan view)

This test shall be carried out after initial state (the specimens shall be conditioned before tests for 24 hours under laboratory conditions at 23 (± 2) ºC and 50 (± 5) % RH. If assessment of durability is performed, then the corresponding specimens shall be conditioned also before and after the following and non-consecutive exposures:

- Hygrothermal cycles (see Clause 2.2.11.1).
- Immersion for 6 h in boiling water at 90 ºC (see Clause 2.2.11.2).
- Immersion for 500 h in water at 20 ºC (see Clause 2.2.11.3).

- - Freeze-thaw cycles (see Clause 2.2.11.3).
- - Long-term exposure to heat (2.500 h at hot dry air 80 ºC) (see Clause 2.2.11.4).

After the corresponding ageing procedure, samples will be rooted and grooved in accordance with the figure D.2, for TMCS based on solid core and on figure D.3 for TMCS based on honeycomb core.



1. Specimen a: Front skin / Specimen b: Rear skin
2. Specimen a: Rear skin / Specimen b: Front skin
A. Original thickness of TMCS with solid core
B. Non grooved thickness section of TMCS with solid core (B=A-C)
C. Depth of grooved section of TMCS with solid core
D. Upper width of groove (depends on TMCS thickness)
E. Lateral band width (depends on TMCS thickness; D+E=25 mm)

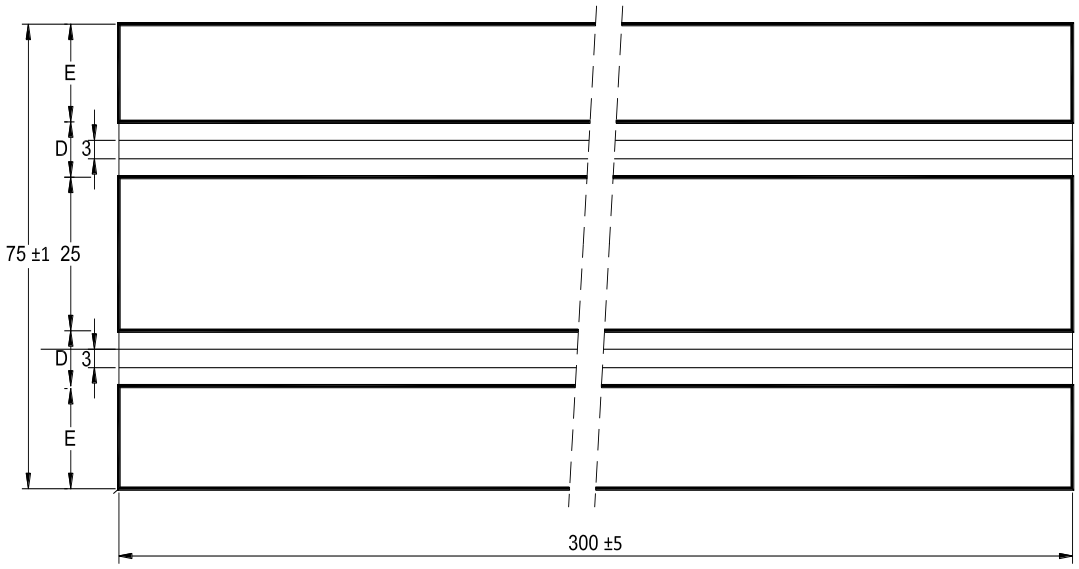
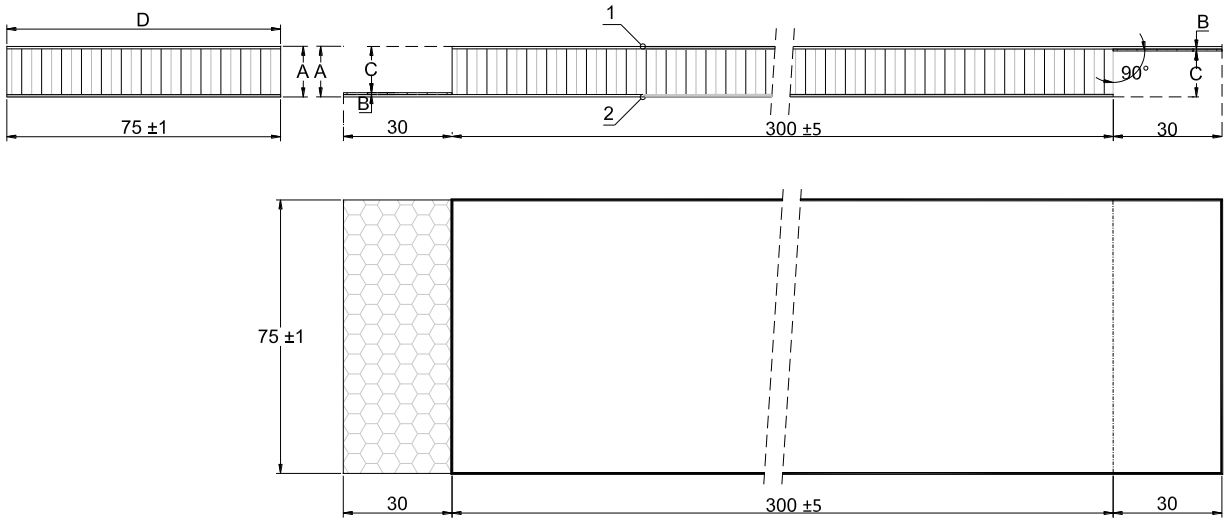


Figure D.2. Vertical (up) and plan (bottom) views of specimen sampled from TMCS with solid core (dimensions in mm)



1. Specimen a: Front skin / Specimen b: Rear skin
2. Specimen a: Rear skin / Specimen b: Front skin
A. Original thickness of TMCS with honeycomb core
B. Non grooved thickness section of TMCS with honeycomb core (B=A-C)
C. Depth of grooved section of TMCS with honeycomb core
D. Width of groove (same width of specimen)

Figure D.3. Front (up-left), lateral (up-right) and plan (bottom) views of specimen sampled from TMCS with honeycomb core (dimensions in mm)

Description of specimens: Batch and date of manufacture, type of sheet, thickness of sheet, thickness of metallic sheets, location on sheet side (left, central or right) and metallic sheet – core position (top or bottom).

D.1.2 - Test equipment and procedure

The test equipment consists of universal testing machine and a peeling test device composed by a climbing drum of outside diameter (50 ± 2 mm), guiding flexible cables or strips (Figure D.5) able to be rolled and unrolled on its flanges, and a base and columns.

Once already grooved and prepared, the specimen is fixed by the clamp of the internal cylinder of the climbing drum clamp whereas the other side of the specimen is fixed.

An initial load F_0 is applied to roll the skin of the specimen on the climbing drum until a constant value is obtained (initial resistance torque). After that the drum climbs and applies tangentially a peeling load (torque strength) moving up along the specimen at constant load (speed 25 ± 3 mm/min) at least for a minimum peeling distance 150 mm. Load-displacement curve shall be recorded. Displacement refers to the length of the specimen which is tangentially peeled by the climbing drum, and its smaller than the length of the specimen. The load is controlled through the universal testing machine.

Description of specimens: Batch and date of manufacture, type of sheet, thickness of sheet, thickness of metallic sheets, location on sheet side (left, central or right) and metallic sheet – core position (top or bottom).

The effective torque arm shall be calculated considering the drum radius, the radius of the flanges where the cables or straps are positioned, the thickness of the cables or straps and the thickness of the metallic sheet to be peeled.

For example, when the outside radius of the drum is 51 mm and the radius of the flanges, including one half of the cables or straps thickness is 12,7 mm greater than the radius of the drum, the effective torque arm is this 12,7 mm less half of the metallic sheet to be peeled.

The torque by peeling strength is calculated as follows:

$T_i = [(r_{fl} - r_{dr}) \times (F_1 - F_0)] / w_i$

where:

T_i = torque strength individual value of each specimen (in N.m/m).

r_{fl} = flange radius plus one half of the load cables or straps thickness (in mm).

r_{dr} = drum radius plus one half of the metallic sheet thickness (in mm).

F_1 = average load required to bend and peel the metallic sheet plus the load required to overcome the resisting torque (in N). This average load shall be determined from the peeling diagram along a peeling distance of at least 150 mm, of which the first 25 mm are not considered by using a planimeter as the average of force values registered at predetermined increments of 5 seconds after the initial peak (0 mm) (Fig. D.4).

F_0 = load required to overcome the resisting torque (in N).

w_i = width of each specimen (in mm).

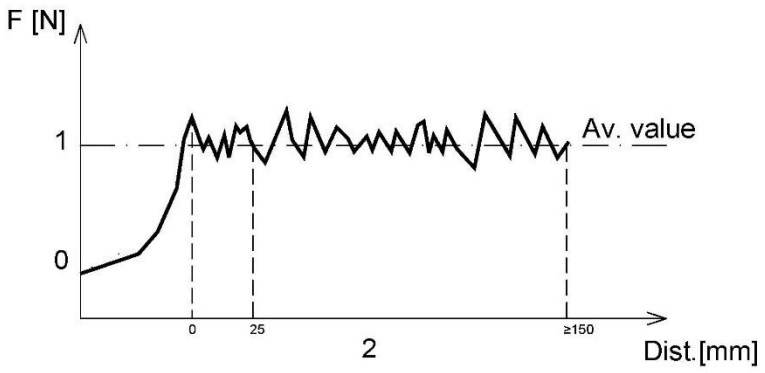
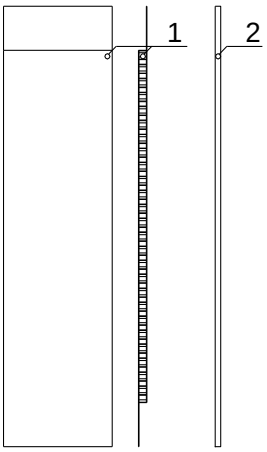


Figure D.4. Example of peeling diagram

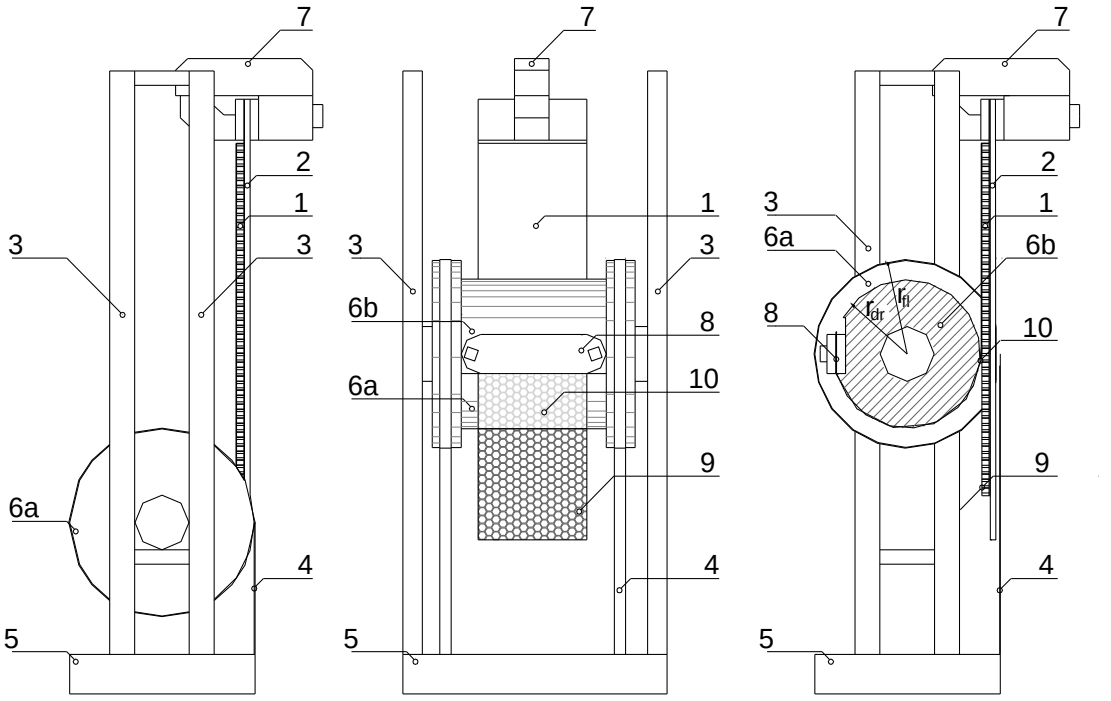


1. Specimen of TMCS with solid core
2. Metal solid strip 4 mm bonded to specimen non-peeled skin if its thickness = 6 mm to avoid its bending
3. Pillar of peeling test device
4. Guiding strips of climbing drum
5. Base of peeling test device

6a. Climbing drum external flanges (radius r_{fl})

6b. Climbing drum internal cylinder (radius r_{dr})

7. Clamp to fix TMCS specimen
8. Clamp to fix TMCS skin to be peeled from core
9. Core of TMCS being peeled by climbing drum
10. TMCS skin being peeled from core

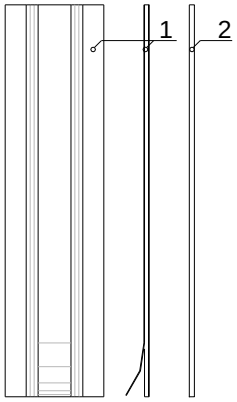


A. Start of test. Climbing drum at its lowest position (side view)

B. Development of test. Climbing drum at its intermediate position. Specimen is being peeled along its length (front view)

C. Development of test. Climbing drum at its intermediate position. Specimen is being peeled along its length (vertical section view)

Figure D.5. Peeling test equipment for TMCS with honeycomb core (dimensions in mm)

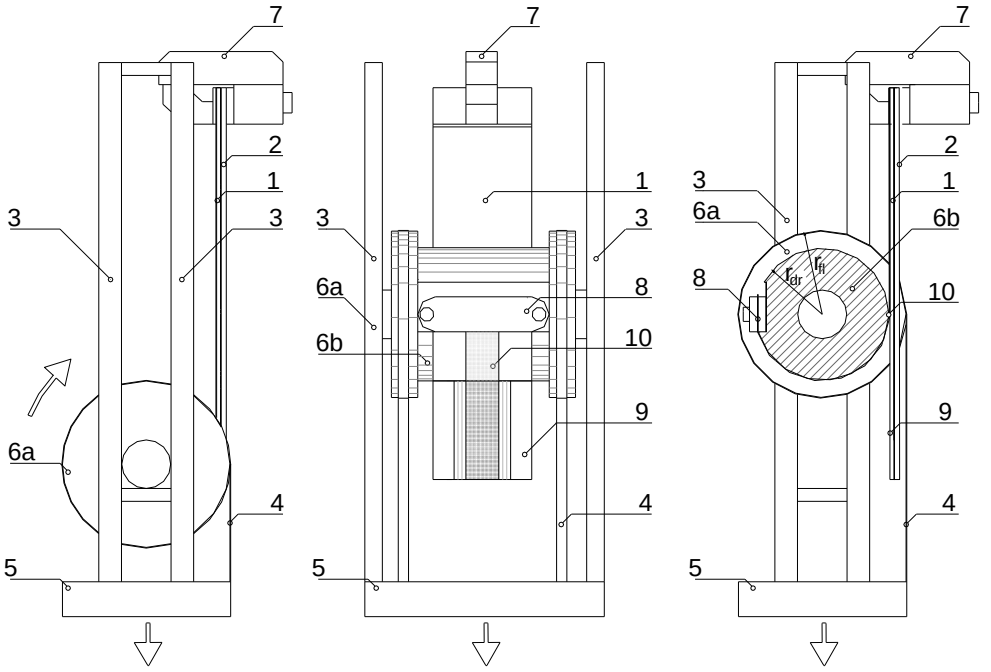


1. Specimen of TMCS with solid core
2. Metal solid strip 4 mm bonded to specimen non-peeled skin if its thickness = 6 mm to avoid its bending
3. Pillar of peeling test device
4. Cable or straps (un)rolled on climbing drum
5. Base of peeling test device

6a. Climbing drum external flanges (radius r_{fl})

6b. Climbing drum internal cylinder (radius r_{dr})

7. Clamp to fix TMCS specimen
8. Clamp to fix TMCS skin to be peeled from core
9. Core of TMCS being peeled by climbing drum
10. TMCS skin being peeled from core



A. Start of test. Climbing drum at its lowest position (side view)

B. Development of test. Climbing drum at its intermediate position. Specimen is being peeled along its length (front view)

C. Development of test. Climbing drum at its intermediate position. Specimen is being peeled along its length (vertical section view)

Figure D.6. Peeling test equipment for TMCS with solid core (dimensions in mm)

D.1.3 - Expression of the results

Torque peel strength, at initial state (T_{INI}) and after respective ageing shall be expressed in N.m/m, plus ratio or relative change expressed in % (as indicated in chapter 2.2.11 and using symbols as indicated in clause 2.2.7).

Description of any cracks or breakage on metallic skin occurred during peeling test.

Description of any signs of degradation after visual inspection on each specimen after exposure and after testing.

ANNEX E HARD BODY IMPACT RESISTANCE

The test of hard body impact resistance of the TMCS shall be carried out in accordance with the following test procedure on three test specimens for single thickness of TMCS at least. The test is to be performed on one set of test specimens conditioned for 24 hours at normal conditions (as described at Clause 2.2:+23 ± 2 °C and relative humidity (50 ± 10%)) and on one set conditioned for 24 hours at -20 °C.

Each test shall be carried out on new sheet of product of dimensions 600 × 600 mm at least and consists of one impact of impact energy selected from range 1, 3, 5 and 10 N*m (see Figure. F.1) to the test specimen.

The tested specimen shall be positioned horizontally on beams (e.g., wooden) of height 80 mm at least with axial distance 500 mm without additional fixing (see Figure F.1). The top edge of the sheet is struck by hard body impactor (steel ball) in vertical direction.

The hard body impactor with mass (m) is dropped from a height (h), so that the total impact energy ($E = g \times h \times m$) corresponds with one of:

- Hard body impact (5 N*m and 10 N*m) is carried out with steel ball weighing 1 kg.
- Hard body impact (1 N*m, 3 N*m and 5 N*m) is carried out with steel ball weighing 0.5 kg.

The height is measured between the designated point of impact on surface of test specimen and the bottom of hard body impactor before its releasing.

The presence of any micro cracks or cracks at the impact point and at the circumference and area of the cracked zone are noted, measured and recorded. The nature of any breakage (e.g., sharp points or edges or delamination) is recorded.

The test result is expressed as type of damage or “without damage” for impact energy in *N*m*.

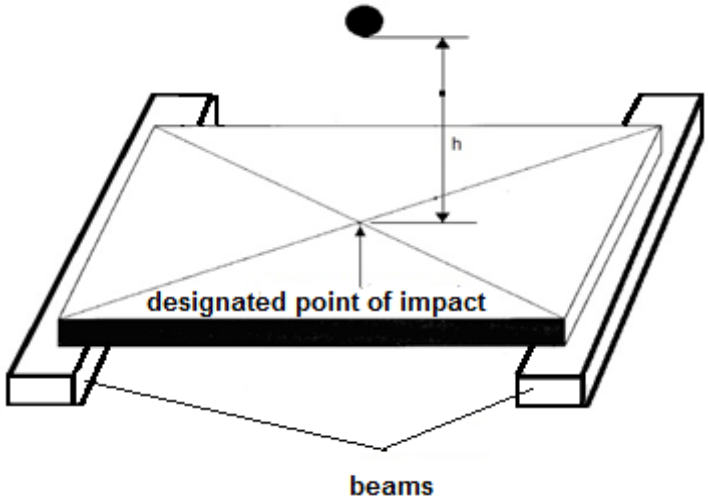


Figure E.1. Assembly for hard body impact test

The test report shall contain at least characteristics mentioned below:

- Description of test specimen (nominal thickness of TMCS, material and nominal thickness of faced skins, material of core composition).
- For each tested specimen conditions of test (impact energy, conditioning) and description of test result.

ANNEX F CREEP TEST

The principle is to establish the mechanical resistance of the TMCS to long term or permanent dead load (creep test). One specimen (at least the minimum thickness) shall be usually sufficient to determine the creep resistance.

The test specimens shall be exposed with its front skin facing down, to a test load F according to at least one the options described below, depending on the foreseen span of the intended use:

- Option 1: four-point bending test arrangement when the span is equal or greater than 300 mm, points at L = span/3, and;
- Option 2: three-point bending test arrangement when the span is smaller than 300 mm, point at L = span/2.
-

Test load F shall be calculated as 30% of average value of initial bending strength ($F_{bend,INI}$) in accordance with 2.2.5.1 for four point bending test arrangement as the 30 % of the average value of the flexural strength ($F_{flex,INI}$) in accordance with 2.2.5.2 for three-point arrangement.

During the placing of the test load, the test specimen shall be propped from below in such a way that the propping can be removed quickly and smoothly in order to initiate the test.

The measurement of “zero“ deflection shall be registered, and then displacement measurements shall commence the instant that the full load is applied (w_0) and then as w_t in intervals 1; 2; 4; 8; 24 hours, 2; 4; 7; 14; 28; 56; 84 days (i.e. 2000 hours). After end of loading period, test load shall be removed carefully without any propping of test specimen and displacement $w_{t,0}$ measured in intervals 1; 2; 4; 8 and 24 hours, or finished later when no change to previous measurement is detected.

The creep coefficient φ_t [-] for TMCS shall be calculated using the expression:

$$\varphi_t = \frac{w_t - w_0}{w_0 - (w_t - w_{t,0})}$$

where w_t = the total deflection under load measured at time t (from 28 days as minimum, 56 days or 84 days, about 2000 hours),

w_0 = the total initial deflection under load measured at the time t = 0

$w_{t,0}$ = the total displacement measured after removing of test load after 24 hours as minimum from end of test, or later when no change to previous measurement is detected.

The test report shall contain at least:

- Description of test specimen (nominal thickness of TMCS, material and nominal thickness of faced skins, type of core composition).
- Test load F applied.
- Each measured deformations at intervals given above and calculated creep coefficient.

The data that shall be stated in the ETA are: Creep coefficient φt [-], the applied load F [in N], and the span considered in the test.