

EUROPEAN ASSESSMENT DOCUMENT

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SELF SUPPORTING TRANSLUCENT ROOF KITS WITH COVERING MADE OF PLASTIC 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 No (EU) 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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1 SCOPE OF THE EAD

1.1 Description of the construction product

The EAD covers self-supporting translucent roof kits with covering made of plastic sheets, which the manufacturer places on the market. The components of the kits are prefabricated construction products and are assembled to roof lights on building site in accordance with the manufacturer guideline. The covering itself is mainly composed of single or multi-layer polymeric translucent sheets (optionally combined with opaque elements) and support profiles. The covering sheets may be supported by covering profiles with or without additional bearing profiles.

The shape of the roof kits can be curved (e.g. barrel-shaped) or flat (e.g. single or double pitch) or be shaped in such a way that parts of it are vertical. For use as a flat roof a minimum slope (e.g. 5° from the horizontal) of the covering from eave to ridge is necessary.

The mainly components of the self-supporting translucent roof kits are:

- Covering (sheets)
- Covering profiles (optional)
- Bearing profiles (optional)
- Support profiles
- Sealings
- Fixings

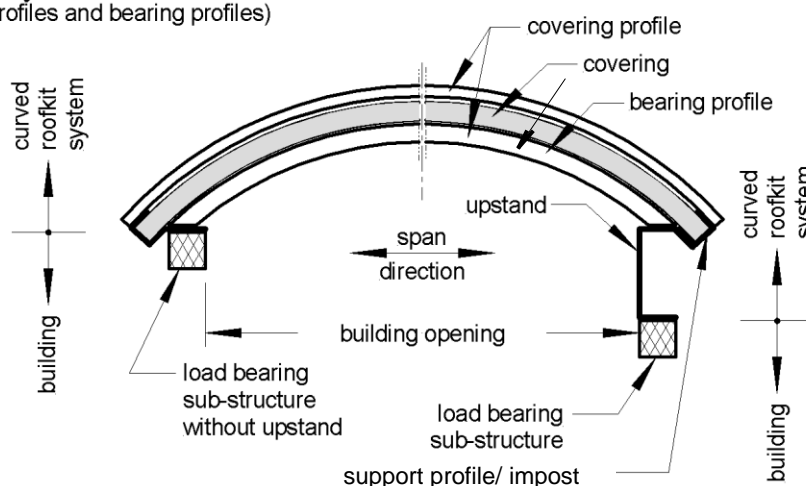
The self-supporting translucent roof kits can be divided in the following families (see figure 1, a-d):

- a) Curved roof kits with bearing profiles
- b) Curved roof kits without bearing profiles
- c) Flat roof kits with bearing profiles
- d) Flat roof kits without bearing profiles

The EAD does not cover the load-bearing sub-structure and its fixing to the building, the optionally used upstands or single openings for day-to-day ventilation and smoked heat exhaust ventilation constructions. These have to be assessed separately in accordance with the relevant technical specifications.

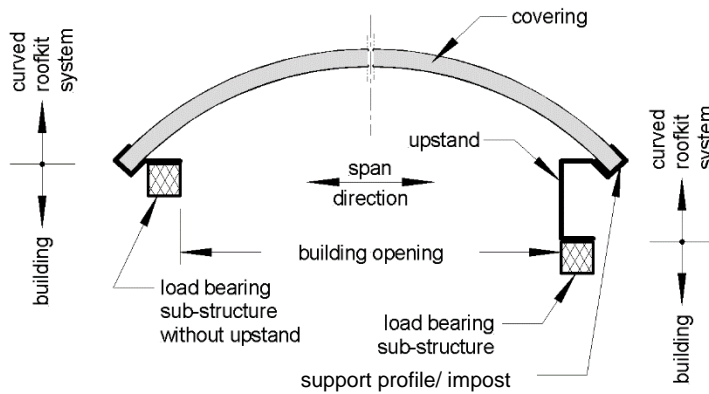
curved roofkit system

(with covering profiles and bearing profiles)



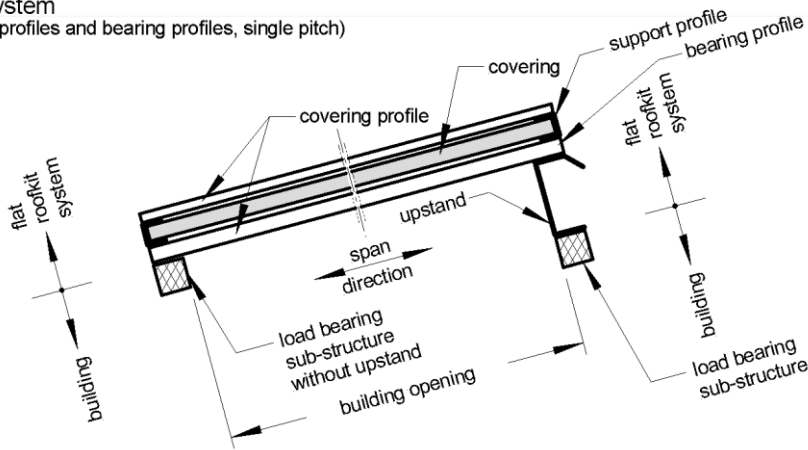
- a) Curved roof kits with bearing profiles (with or without upstand)

curved roofkit system
(without covering profiles and bearing profiles)



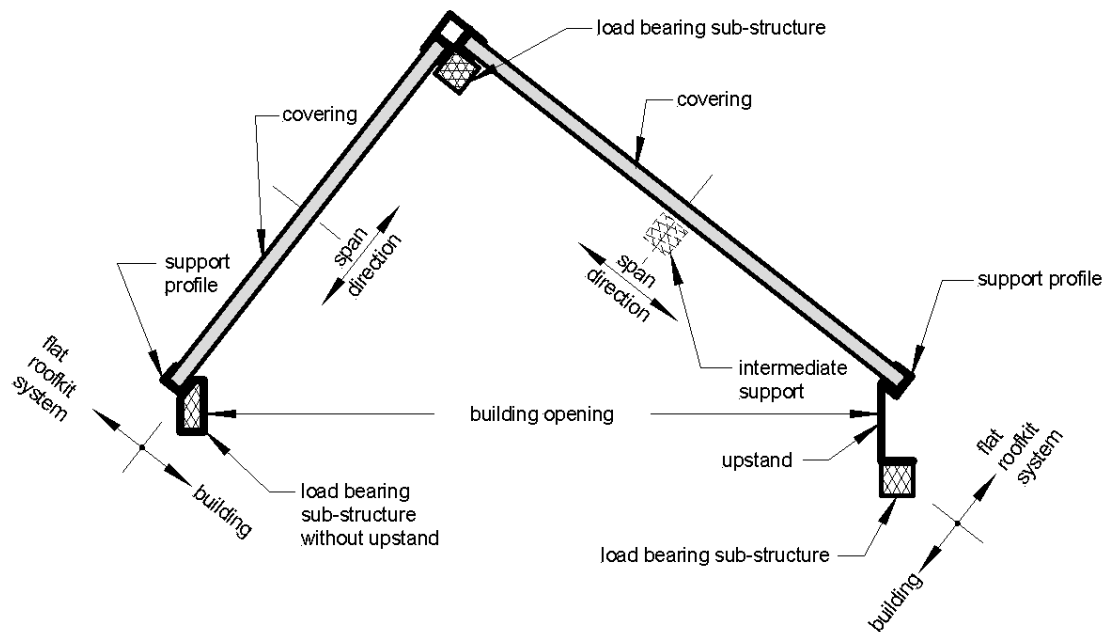
b) Curved roof kits without bearing profiles (with or without upstand)

flat roofkit system
(with covering profiles and bearing profiles, single pitch)



c) Flat roof kits with bearing profiles (with or without upstand)

flat roofkit system
(without covering profiles and bearing profiles, double pitch)



d) Flat roof kits without bearing profiles

Figure 1: schematic drawing of different roof kit families (a to d)

The self-supporting translucent roof kits are not fully covered by the following harmonised technical specification EN 14963¹:

- The assessment methods accord. to EN 14963 with regard to the mechanical resistance to upward and downward loads (section 5.4.2 and 5.4.3 of the hEN, only one test required) do not provide the characteristic values of the resistance that are needed by the designers and the users of the roof-kit.
The assessments methods in the EAD, section 2.2.5 allow a statistical analysis of the test results and the determination of characteristic values as well as the material-dependant influence factors. These are relevant for the design of the kit with plastic sheets.
- EN 14963 limits the range of application to roof-in-roof constructions and to kits with a maximum inclination of 10° from the horizontal.

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 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.

¹ All undated references to hEN or standards at prEN stage, EOTA report etc. in this EAD are to be understood as references to the dated versions listed in clause 4.

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

1.2.1 Intended use(s)

The self-supporting translucent roof kits are intended to provide weather protection and daylight illuminance to any enclosed or partially enclosed building or space. They are intended to be used as continuous roof lights of any length with a plane layout as roof covering for open and closed structures. The self-supporting translucent roof kits transfer dead loads, snow and wind loads to the load-bearing substructure.

For the presumed working life the covering made of plastic sheets has to fulfil at least the requirements with respect to durability of Type ΔD in accordance with EN 14963: 2006, Table 1. ("Material classification according to the change of light transmittance and yellowness index"); the corresponding factors C_u and K_u are to be determined according to EN 14963:2006 Table 2.

Additional fasteners (e.g. screws) or fixing elements (e.g. suction anchors / spacers) are usually needed.

The coverings are not to be walked on.

The self-supporting translucent roof kits shall not be used for bracing of the support structure.

Use for fall protection is not covered by this EAD.

The self-supporting translucent roof kits made out of plastic materials are not intended to contribute to the resistance to fire of the building, therefore, resistance to fire is considered irrelevant for this product.

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 the self-supporting roof kits for the intended use of at least ten years when installed in the works (provided that the self-supporting translucent roof kits are 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 shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works².

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 (if necessary in addition to the definitions in CPR, Art 2)

1.3.1 Specific terms

1.3.1.1 Self-supporting roof kit

Construction product used to enclose a space, to protect it from the weather and to provide daylight illuminance and capable of transferring permanent and variable loads except live loads to the substructure

² 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.

1.3.1.2 Covering

The main parts of the covering are the sheets. This EAD primarily covers sheets made from glass reinforced polyester resin (GRP), polyvinyl chloride (PVC), polycarbonate (PC), and polymethyl methacrylate (PMMA) or other plastics. The sheets can be solid or multi-wall sheets. They can be flat or corrugated. They can have a clip connection at their longitudinal edges.

Some of the sheets are covered by harmonized standards. The following standards may apply:

EN 1013:2015-03	"Light transmitting single skin profiled plastics sheets "for internal and external roofs, walls" and ceilings –Requirements and test methods"
EN 16153:2013+A1:2015	"Light transmitting flat multiwall polycarbonate (PC) sheets for internal and external use in roofs, walls and ceilings – Requirements and test methods"
EN 16240:2014-03	"Light transmitting flat solid polycarbonate (PC) sheets for internal and external use in roofs, walls and ceilings – Requirements and test methods"

Covering may also involve function layers (e.g. glass fibre mats).

1.3.1.3 Span

Span is the distance in direction of load bearing between the supports, usually it is the shortest distance between the edges of the building openings.

1.3.1.4 Covering profiles

Profiles supporting the covering on both sides (inside and outside) in direction of the span with a defined minimum support width (b_a see Fig. 2). They are also used for framing the longitudinal edges of the covering.

1.3.1.5 Bearing profiles

Profiles bearing the loads introduced by the covering (dead load, snow, wind) in direction of the span. The lower (inside) covering profile can be a part of the bearing profile (see Fig. 2). The bearing profiles have to be stable on their own and have to be calculated in accordance with the relevant Eurocodes or relevant harmonized technical specifications shall apply. Other profiles in direction of the span which cannot be calculated separately are considered as stiffeners and therefore need to be assessed in combination with the covering.

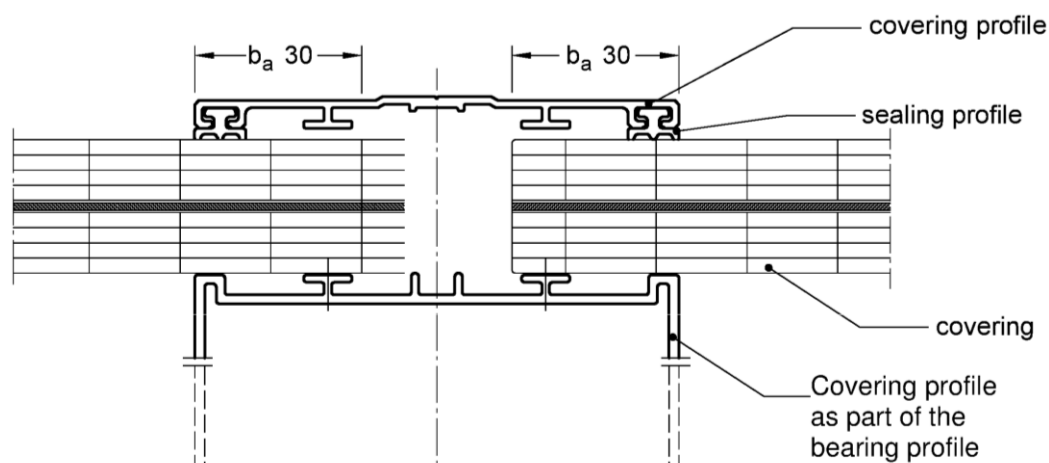


Figure 2: Example for support width b_a of the covering profiles

1.3.1.6 Support profiles

Profiles (with or without thermal barriers) transferring the loads to the load-bearing substructure of the building or to an intermediate structure, e.g. an upstand. They could be used for framing the front side of the covering.

1.3.1.7 Impost

Special support profile for curved systems (base of the arch), which can be used for transferring tensile loads due to uplift loads on the covering.

1.3.1.8 Upstand

The upstand is an element which is single- or multi-walled or composite with vertical and/or pitched walls; with or without thermal insulation and having the dual purpose of providing an area for the fixture of the kit and for connecting it to the load-bearing substructure. It transmits the loads acting upon the kit into the load-bearing substructure.

1.3.1.9 Load-bearing substructure

The load bearing substructure transfers the loads entered from the kit to the building structure..

1.3.2 Symbols and abbreviations

B_{EI}	Bending stiffness
M	Moment
N	Tensile strength in profile direction
V	Tensile strength transverse to profile direction
F	Applied force
L	Span
s	Deflection
E_c	Creep modulus
E_{1h}	E modulus calculated from the deflection after 1 h load duration
s_{1h}	Deflection after 1 h load duration
s_{24h}	Deflection after 24 h load duration
s_c	Creep deflection
R_k	Characteristic value of resistance, for the ultimate limit of load bearing.
C_k	Characteristic value of resistance, for the limit of serviceability.
C_t, C_u, C_θ	Material-dependent influence factors (duration of loading, ageing/environmental effects and temperature respectively)
K_t, K_u, K_θ	Influence factors for breaking strength (duration of loading, ageing/environmental effects and temperature respectively)
φ_t	Creep factor
σ	Strength
ε	Strain
R_W	Sound reduction index
τ	Transmission coefficient, transmittance
ρ	Reflectance
R (value)	Thermal resistance (m^2K/W)
U_{rc} (value)	Thermal transmittance (W/m^2K)
g	Total solar energy transmittance
U_{ti} :	Thermal transmittance coefficient of the covering (translucent part) in $W/(m^2K)$
A_{ti} :	Area of the covering (translucent part) in m^2
U_{pi} :	Thermal transmittance coefficient of the covering, profiles, support in $W/(m^2K)$
A_{pi} :	Area of the covering, profiles, support structure in m^2
U_{tg} :	Thermal transmittance coefficient of the gable (translucent part) in $W/(m^2K)$
A_{tg} :	Area of the gable (translucent part) in m^2
U_{up} :	Thermal transmittance coefficient of the upstand in $W/(m^2K)$
A_{up} :	Area of the upstand in m^2
$\Psi_{g,j,up}$:	Linear thermal transmittance coefficient at the level of the connecting profiles [$W/(m K)$]
$l_{g,j,up}$:	Connecting profile length in m

A_r, A_{rc} :	Total surface of the roof kit in m^2
V_o	Calculated airflow
V_x	Measured airflow
T_x	actual temperature T_x , in $^{\circ}C$
P_x	atmospheric pressure P_x , in kPa

(Indices not explained refer to the Eurocode)

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1 shows how the performance of "Self-supporting translucent roof kits with covering made of plastic sheets" is assessed in relation to the essential characteristics.

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	Clause 2.2.1	Class
2	External fire performance	Clause 2.2.2	Class
Basic Works Requirement 3: Hygiene, health and the environment			
3	Content, emission and/or release of dangerous substances	Clause 2.2.3	Description
4	Watertightness	Clause 2.2.4	Category
Basic Works Requirement 4: Safety and accessibility in use			
5	Load-bearing capacity: <ul style="list-style-type: none"> - Characteristic structural resistance <ul style="list-style-type: none"> • resistance to upward loads and downward loads of the covering • Interaction of reaction at supports/ moment of resistance at intermediate supports for multi-span systems of the covering - Deformation behaviour of the covering - Pull out of screws out of metal profile channels - Tensile strength of the impost (made of plastic) - Support reaction of metal profiles with thermal barrier - Design relevant material-dependent influence factors: <ul style="list-style-type: none"> • effect of load duration • ageing and environmental effects • thermal effects 	Clause 2.2.5 2.2.5.1, a) –c) 2.2.5.1, d) 2.2.5.2, a) 2.2.5.2, b) 2.2.5.2, c) 2.2.5.2, d) 2.2.5.3	R_k / C_k [kN/m ²] $F_{R,k}$ [kN/m] / $M_{R,k}$ [kNm/m] $F_{C,k}$ [kN/m] / $M_{C,k}$ [kNm/m] B_{EI} [Nm ² /m] $N_{R,k} / V_{R,k}$ [kN] $N_{C,k} / V_{C,k}$ [kN] $N_{R,k} / N_{C,k}$ [kN/m] $F_{R,k}$ [kN/m] C_t / K_t C_u / K_u C_θ / K_θ

No	Essential characteristic	Assessment method	Type of expression of product performance
6	Resistance to damage by impact loads with a soft object (50 kg)	Clause 2.2.7	Category
7	Resistance to impact loads from a hard object (250 g)	Clause 2.2.8	Level
Basic Works Requirement 5: Protection against noise			
8	Airborne sound insulation	Clause 2.2.9	R_w [dB]
Basic Works Requirement 6: Energy economy and heat retention			
9	Thermal transmittance (performance)	Clause 2.2.10	U_r [W/(m ² ·K)]
10	Air permeability	Clause 2.2.11	Category
11	Radiation properties - Light transmission - Total solar energy transmittance	Clause 2.2.12	τ_{D65} [%] g [%]
Other essential characteristics			
12	Aspects of durability	Clause 2.2.6	Category

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

2.2.1 Reaction to fire

Reaction to fire of the roof kits shall be assessed by considering the reaction to fire of the components, in order to be classified according to Commission Delegated Regulation (EU) 2016/364 in connection with EN 13501-1. Mounting and fixing rules for the SBI-testing according to EN 13823 shall be in accordance with the relevant harmonized specifications of the sheets (see clause 1.3). Components which are classified on bases of their harmonized specification do not need to be retested.

Metallic profiles (see clause 1.1) are considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire in accordance with the EC Decision 96/603/EC (as amended) without the need for testing on the basis of it fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

The sealing profiles do not have contribution to fire spread in accordance with EOTA TR 021 and therefore do not need to be tested.

The whole roof kit shall be classified based on the worst class of any component.

The reaction to fire classification according to Commission Delegated Regulation (EU) No 2016/364 in connection with EN 13501-1 components shall be stated in the description of the roof kit in the ETA.

2.2.2 External fire performance of roofs

The roof in which the kit is intended to be applied shall be tested using the test method (given in EN 13501-5) relevant for the corresponding external fire performance roof class, in order to be classified according to EC Decision 2001/671/EC (as amended) in connection with EN 13501-5.

2.2.3 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer³ after identifying the release scenarios (in accordance with EOTA TR 034) taking into account the intended use of the product and the Member State where the manufacturer intends his product to be made available on the market.

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

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

2.2.3.1 Leachable substances

For the intended use covered by the release scenario S/W2 the performance of the sealing profile concerning leachable substances has to be assessed. A leaching test with subsequent eluate analysis must take place, each in duplicate. Leaching tests of the sealing profile are conducted according to CEN/TS 16637-2:2014. The leachate shall be pH-neutral demineralised water and the ratio of liquid volume to surface area must be 20 -25 l/m².

Plates of the sealing profile material with dimensions of 100 mm x 100 mm shall be prepared.

In eluates of "6 hours" and "64 days", the following biological tests shall be conducted:

- Acute toxicity test with *Daphnia magna* Straus according to EN ISO 6341
- Toxicity test with algae according to ISO 15799
- Luminescent bacteria test according to 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 tests shall be conducted with the eluates of "6 hours" and "64 days" eluates:

- Biological degradation according to OECD Test Guideline 301 part A, B or E.

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

³ 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 according to 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.

2.2.4 Watertightness

2.2.4.1 General

A constant and specified quantity of water over the exterior surface of the specimen shall be applied. Initially with no imposed over pressure then with positive pressure steps it shall be applied to the exterior face. The penetration of any water has to be visually observed and noted.

2.2.4.2 Test setup

A chamber should have a size over which the test specimen can be fitted. The chamber may be adaptable to various sample sizes but must be sufficiently rigid such that, under the self-weight of the sample and the influence of applied pressure, it does not distort and thus apply undue stress to the test sample that might affect its performance. The chamber shall be equipped with viewing windows.

The air pressure within the test chamber shall be reduced to create a differential positive pressure to the sample with respect to its exterior face.

The applied differential pressure shall be measured with an accuracy $\pm 5\%$.

A device for spraying water at 2 to 3 l / (m² minute) shall be adjusted so that a constant and continuous film is applied to the exterior surface of the specimen.

The water spraying device shall have nozzles spaced on a square grid at maximum 700 mm centres and at a uniform distance of 200 ± 5 mm from the highest point of the specimen.

The local water supply shall be an acceptable source provided it is clean enough to allow the spray nozzles to function properly throughout the test. The nozzles shall provide a full square pattern relative to the horizontal plane.

The total amount of water supplied shall be measured with an accuracy of $\pm 5\%$. The water spray apparatus shall be regularly calibrated.

A drain for the sprayed water shall not interfere with the drainage of the specimen.

Test specimen: A test specimen shall be constructed which includes eaves gutter and verge details and, in the case of roofs formed from repeatable units, any intermediate gutter between units.

The sample shall be constructed in its normal orientation over the test chamber.

2.2.4.3 Test procedure

Water spray shall be commenced visually ensuring all nozzles are functioning correctly and providing a constant and continuous film of water over the exterior surface of the specimen.

Water flow is adjusted to provide the rate calculated from the area covered and the requirement for 2 to 3 l / (m² minute).

After a zero air differential pressure period, pressure steps are applied as specified and at required time intervals. The frame joints and interior surface are constantly inspected for possible onset of leakage. If necessary, permanent ventilation may be blocked in order to achieve the required air pressures for test purposes.

2.2.4.4 Watertightness categories

The performance of the self-supporting translucent roof kits is categorised as a result of the tests above.

Category	Performance
1	No leakage with no differential air pressure
2(x)	No leakage up to a defined pressure differential (x) Pa.

Note: The classes originate in ETAG 010.

The category shall be given in the ETA.

2.2.5 Load bearing capacity

The load bearing capacity of the covering in the system is to be determined by full scale testing on representative repeatable units. Where parts of the system (e.g. support profiles) cannot be evaluated separately by calculation according to the related Eurocodes, they have to be part of the kit to be tested.

The design of the test setup and the used components shall correspond to the proposed usage. The test setup shall comprise an assembly of units with realistic peripheral conditions (in particular the support conditions of the sheets) for the roof kit to be assessed.

Therefore, the test methods have to be taken from following flow chart:

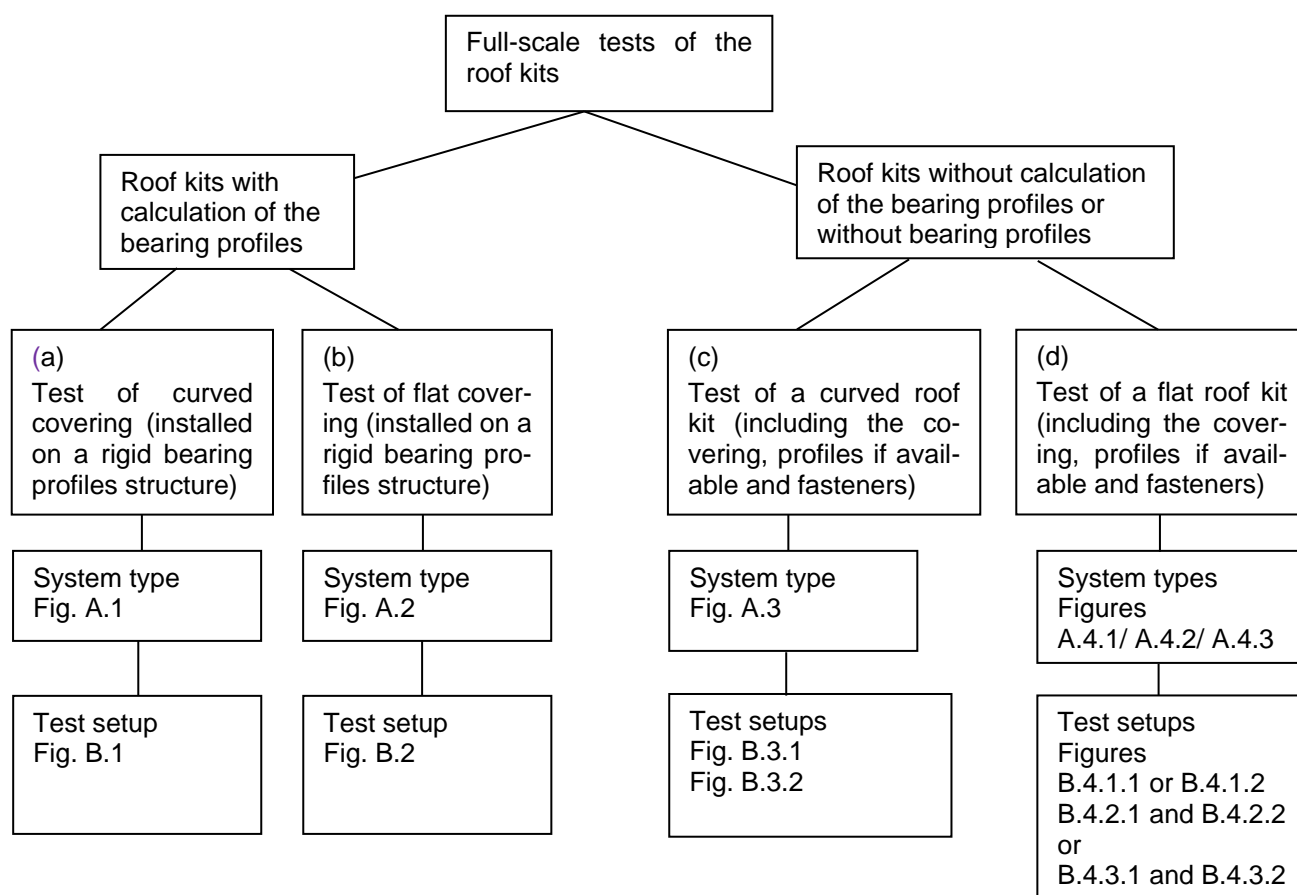


Figure 3: Overview showing the relationship between family of roof kits and test setup

The determination of mechanical resistance and stability – ultimate load bearing capacity and serviceability - shall to be undertaken on the basis of EN 1990:2002 + A1:2005 + A1:2005/AC:2010 respectively relevant harmonized technical specifications shall apply.

2.2.5.1 Full-scale tests of the roof kit

All tests shall be carried out under standard atmospheric conditions 23/50, Class 2, according to EN ISO 291. For each test series, the limit states for load-bearing capacity and, where applicable, serviceability shall be analysed statistically and the characteristic values shall be determined according EN 1990/Table D1, $V_{x,unknown}$. The variation coefficient shall be based on the standard deviation of the logarithmic values. If not otherwise indicated, at least 3 tests shall be performed. All relevant characteristics of the sheets used for full scale testing have to be determined (e.g. weight per area, stiffness, buckling moment etc.). It might be necessary to adjust the determined resistance in relation to the guaranteed performance declared by the sheet producer for this specific product type.

In testing, the load type to be simulated shall be applied to the roof kit or part system as an adjustable load. The loads can be applied either as uniformly distributed loads (e.g. by vacuum or air bag) or as point loads (e.g. sandbags or individual weights).

Note: single loads are not allowed to stiffen the structure or to influence each other (bridge building has to be avoided).

The test loads shall increase up to failure in even intervals. The test duration must be more than 6 min (typically 0,5 h up to 1 h).

The design of the test structure and the building elements used shall correspond to the intended use. The test structure shall comprise an assembly of units with realistic peripheral conditions for the roof kit to be assessed.

a) Curved roof kits with bearing profiles

The test structure for this kit is shown schematically in Fig B.1 for downward and uplift loading. For test purposes, to assess the load-bearing capacity and serviceability, the bearing profiles can be braced (propped) e.g. by auxiliary members so that adequate stability is ensured up to the failure load of the covering.

b) Flat roof kits with bearing profiles

For flat roof kits the test structure is shown schematically in Fig B.2. The information given above in a) applies equally to the test structure for this type of kit.

c) Curved roof kits without bearing profiles

The test structure to determine the load-bearing capacity and serviceability is shown schematically in Fig B.3.1. In addition to the test for downward and uplift loading applied over the full span, in curved systems the half-span downward load tests have to be performed.

As the span/height ratio has a significant effect on the load-bearing capacity, the possible displacement of the supports must be taken into account in the full scale tests.

For these systems, if the support anchoring alone is decisive for uplift resistance the test can be restricted to this part of the system (see tensile test in Fig B.3.2).

d) Flat roof kits without bearing profiles

In these systems, the test of the behaviour of the roof system mid-span (moment when shear force is negligible), the test of the behaviour on intermediate supports and an assessment of the acceptable end support reactions are decisive. The test should be generally in accordance with EN 1993-1-3, Eurocode 3, Annex A.2.3 – A.2.5).

The test structure to determine the limit state of bending moment with no transverse force (mid-span moment) is shown schematically in Figs B.4.1.1 and B.4.1.2. If the covering cross-section is not symmetrical, tests are required in both the positive and the negative position. The load to be applied should correspond to a uniformly distributed load which can also be simulated by a minimum of four linear loads, arranged to give approximately the same development of the bending moment in the main load-bearing direction.

The behaviour of the roof systems on the intermediate supports, in particular the interaction between bending moment and support reactions, shall be proven by equivalent beam tests. To this end, the limit states for load-bearing capacity and serviceability shall be determined for at least three different bending moment/support reaction combinations.

The test structure for the equivalent beam tests is shown in Figs B.4.2.1 and B.4.3.1 for downward load application and in Figs B.4.2.2 and B.4.3.2 for uplift loading. If a significant deformation of the covering in perpendicular direction to the span is detected (e.g. between suction anchors) the tests shall be performed with uniform loading instead (see EN 1993-1-3:2006+AC:2009, Fig. A.4)

The intermediate supports shall be representative of the proposed use, particularly their width. The test supports at the ends of the elements rotate freely and can be moved horizontally. Adequate projection of the elements shall be ensured.

Auxiliary constructions may be used which restrict the horizontal displacement or deformations of the elements transverse to the main load-bearing direction. These must not increase the rigidity in the profile direction.

For the end reactions, provided that $l_0 \geq 1,25 \times h$ (=overall thickness of the covering), 60% of the determined maximum intermediate reactions can be used. The end reactions can also be assessed in additional tests.

2.2.5.2 Small-scale tests on sub-systems

If other parts than the covering itself cannot be assessed according to existing calculation methods of the related Eurocodes, they have to be evaluated by further mechanical testing on these sub-systems.

a) Deformation behavior

To determine the deformation behaviour, the creep bending tests based on EN ISO 899-2 shall be performed. Figure 4 shows the corresponding test conditions. The specimens must be symmetrically aligned. To calculate the stiffness, the deflection values "s" after a load duration of 0.1 h shall be used. The effective span, L, shall be 20 times the height h of the sheet and the length of the test specimens l shall be at least $1,1 \times L$. The loads F shall be 30% of the short-time bending strength. At least ten test specimens shall be tested.

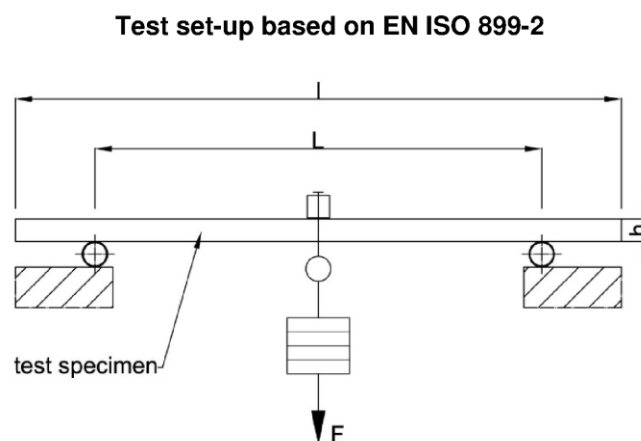


Figure 4: Test set-up (schematic) for the creep bending test

For the determination of the bending stiffness in the three point bending test the following formulae can be used:

$$B_{EI} = (F \cdot L^3) / (48 \cdot s \cdot b)$$

with b = width of the plastic sheet/s

The mean value (arithmetic average) shall be declared in the ETA.

b) Pull out of the screws from the metal profile channels e. g. of the covering profiles

Often the connection of covering profiles and bearing profiles are realized with screws in metal profile channels which need to transfer tension loads.

To determine the characteristic pull-out resistance at least 10 tests have to be performed under standard atmosphere EN ISO 291 -23/50, class 2 and a test speed of 5 – 10 mm/min.

All relevant characteristics have to be described e.g. screw type, the shape of the screw channel and the screw depth.

The test setup for determination of the pull-out strength N in profile direction (e.g. for a covering profile) is shown in Figures 5 and 6.

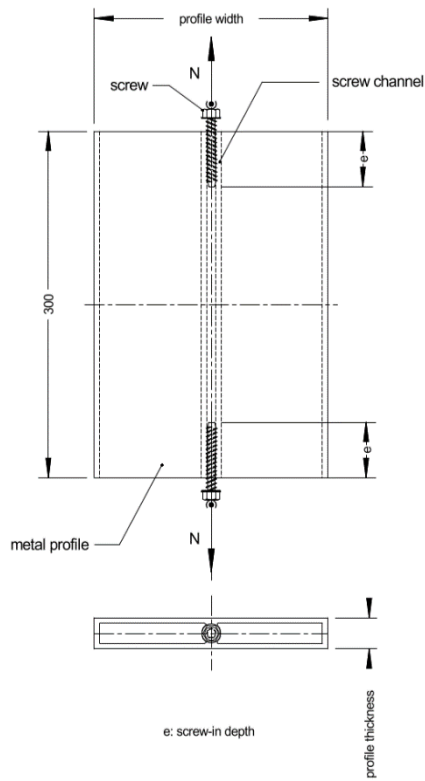


Fig. 5: Pull-out test with one screw

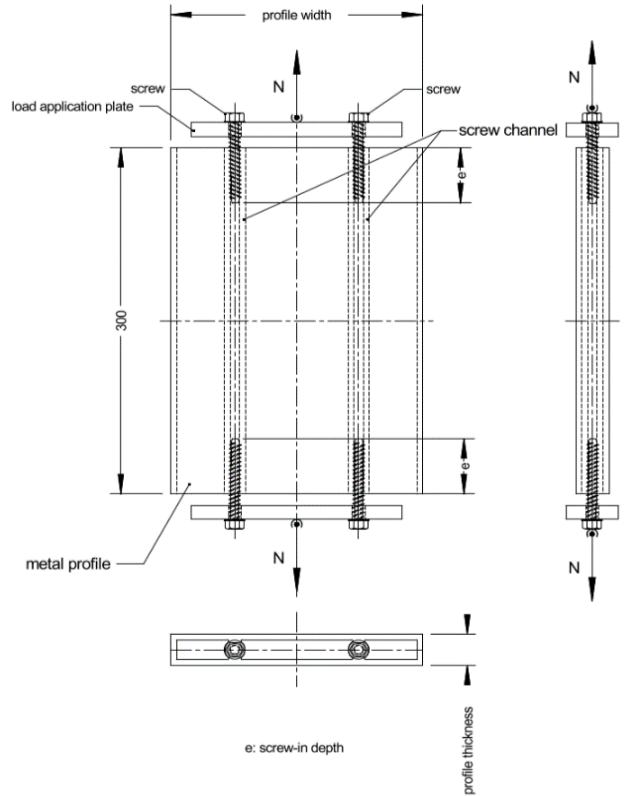


Fig. 6: Pull-out test with two screws

The test setup for determination of the pull-out strength V perpendicular to the profile axis (e.g. for a bearing profile) is shown in Figure 6. In this test it shall be considered, that the screw channel can be widened due to bending. Therefore the test span L has to be equivalent to the regular distance of the screws for this system.

In each case (maximum pull out force N and/ or V) the ultimate limit state have to be determined. If before reaching the maximum force an serviceability limit state is detected, additional alternating load test are required to validate this limit state. The maximum alternating load F_{max} is the assumed load at the point of serviceability. At least 100 load cycles ($F_{min}=0$ up to F_{max}) should be performed within 0,25 h. After the 100 load cycles the short-term test have to be executed again. After the pre-conditioning with alternating tests the determined characteristic load (maximum force) has to be exceeded. Then the assumed load is validated as a serviceability limit state. For validation at least 3 alternating tests are necessary.

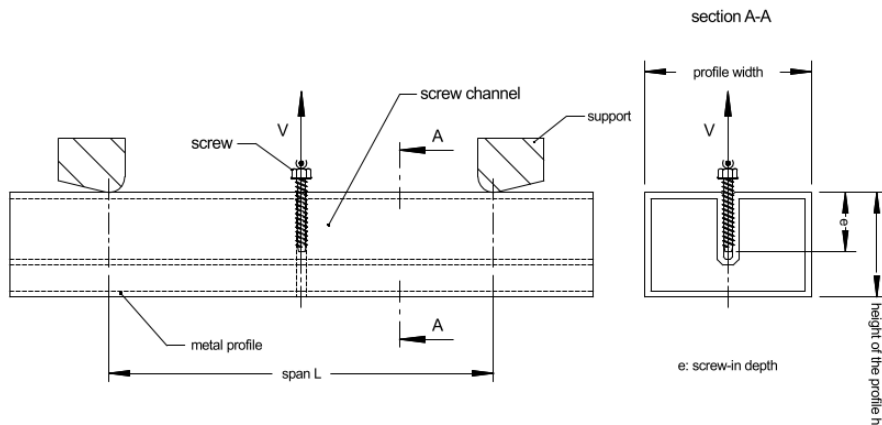


Figure 7: Determination of the pull-out strength V

c) Load bearing capacity of imposts made of plastic

If an impost is designed in that way that plastic parts have to transfer the loads into the sub-construction, additional tests on this sub-system shall be performed to determine the characteristic resistance. At least 10 tests have to be performed under standard atmosphere EN ISO 291 -23/50, class 2 and a test speed of 5 – 10 mm/min. The test setup is shown in Fig. 8.

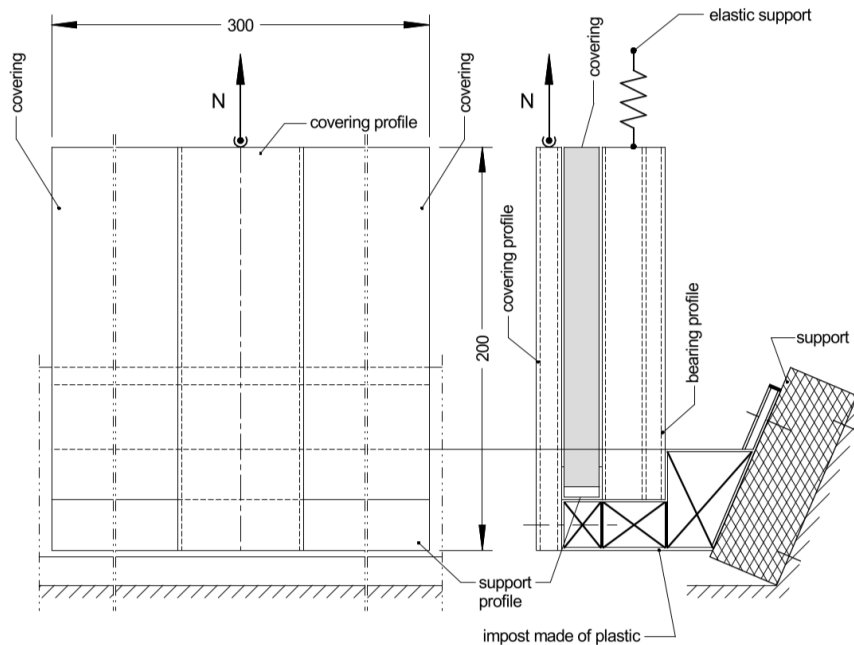


Figure 8: test setup for impost

All tests have to be conducted for the relevant angle of the impost used and for each type of used connection profiles in conjunction with the impost. The bearing profile can be supported in an elastic way to represent the deformation behaviour of the system (bearing profile as a full arc). The support conditions on the load-bearing sub-structure given by the applicant shall be regarded. Therefore the deformation behaviour (force-deformation) has to be recorded. Additionally the limit state of serviceability has to be detected. The serviceability is the first load with irreversible deformations. The limit state of serviceability has to be validated with alternating tests as described in a).

All relevant characteristics have to be described e.g. materials, cross section geometry and lever distance.

d) Load bearing capacity of profiles with thermal barrier made of plastics

If a support profile with thermal barrier according to EN 14024 is used to transfer loads into the sub-construction additional tests on this sub-system shall be performed to determine the characteristic resistance. At least 10 tests have to be performed under standard atmosphere EN ISO 291 -23/50, class 2 and a test speed of 5 – 10 mm/min. The test setup is shown in Fig. 9.

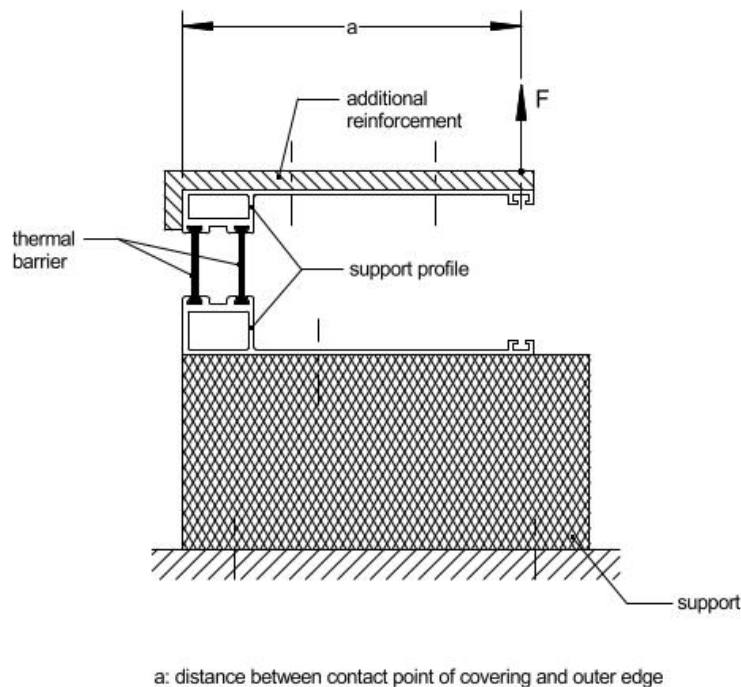


Figure 9: test setup for profiles with thermal barrier

To ensure failure in the thermal barrier made of plastic an additional reinforcement of the metal profile is allowed as shown in Fig. 9.

Note: The material of the thermal barrier and the mechanical resistance are determined in accordance with EN 14024

2.2.5.3 Material-dependent influence factors

To determine the serviceability and load-bearing capacity of the plastic elements in addition to the partial material safety factors, material-dependent influence factors shall also be taken into account. These material-dependent influencing factors are required as input values for the design and describe the changes of the mechanical characteristics due to load duration, aging/weathering and temperature. Depending on the nature of failure of the plastic components of the kit, i.e. deformation-induced or insufficient material strength, the relevant decisive parameters of the material must be used to determine these factors. If the failure of the plastic parts is caused for example by a breakage, the decisive parameter is the bending strength or also the tensile and shear strength. If the failure however is due to slippage at the support or loss of cross-sectional stability, deformation is the decisive parameter. Depending on the failure type (break or deformation failure), the component strength must be adjusted by factor K for strength or factor C for deformation.

Factors are to be taken into account for:

- load duration influences (K_t , C_t) = time dependent exposure (e.g. permanent strain from dead weight)
- ageing and environmental influences (K_u , C_u)
- temperature influences (K_θ , C_θ)

The material-dependent influence factors shall be given in the ETA.

If the material-dependent factors are covered by a hEN (e.g. EN 16153), they have to be adopted. Otherwise the material-factors have to be determined as follows:

2.2.5.3.1 Influence of Load Duration (K_t , C_t)

The influence of load duration can be estimated using time-elongation or time-break curves for the material. The influence of load duration shall be evaluated on a load level of about 30% of the short-time

bending strength of the material. In roof construction systems in which failure of the plastic component is deformation-induced, the decisive factor C_t can be determined from the time-elongation curve in the useful load range (see Fig. C.1.1). The magnification factor is then

$$C_t = (1 + \varphi_t)$$

where the creep factor φ_t covers only the deformation increase due to creep. The creep factor is determined as follows:

$$\varphi_t = (\varepsilon_1 - \varepsilon_0) / \varepsilon_0$$

ε_0 the elongation to the reference period is "very short" (i.e. 0.1 h as a rule) and ε_1 the elongation to the respective design time, e.g. "permanent" = 2×10^5 h.

Fig C.1.2 shows the time-elongation graphs for various stresses up to breaking elongation. The factor φ_t must be determined in the useful load range for a specified load duration. This can vary depending on the duration of the load effect (e.g. self-weight over life span, snow loading during snow load period). In general, it can be assumed that the deformations caused by periodically recurring loads can be compensated during the load-free period. For short-term loads (e.g. wind loads) the material factor $C_t = K_t = 1.0$ should be selected.

For roof kits in which failure is triggered by breakage of the plastic parts, time-strength curves can be used to determine the reduction factor K_t (Fig C.1.2). Factor K_t is the ratio of the short-term strength to the strength after a known load duration. As described above, for design purposes the component strength must be reduced by factor K_t or the load increased by factor K_t .

In cases in which the component geometry or the production process has an effect on the behaviour during the load period or where there is insufficient material data, the factors must be determined by tests on specimens taken from the actual components.

The specimen dimensions must be selected so that a representative, repeatable width is taken from the component. It must be ensured that the test load corresponds to the useful load on the component. Figs C.1.3 to C.1.7 show further examples of test results on test specimens for determination of the magnification factor C_t .

It is not necessary to calculate the time-elongation or time-break curves to determine factors C_t or K_t over the entire duration of load influence, as extrapolation is sufficiently precise. The curves should be shown in double-logarithmic form.

For laminates of glass fibre reinforced unsaturated polyester resins (GRP) the time-elongation-curve, if no cracks are caused by the influence of long time loading, the time-break-curve could be represented as double-logarithmic linear. In this case it is sufficient to determine the magnification factor C_t and the reduction factor K_t by tests with shorter test duration.

If the short term strength is known, three test specimens which do not break after 100 h load duration under a defined load according to an estimated reduction factor K_t , are normally sufficient to prove that K_t is equal to or smaller than the estimated value.

2.2.5.3.2 Ageing and Environmental Influences (K_u , C_u)

The ageing and environmental influences on the decisive parameters, e.g. due to UV radiation or weathering, can be assessed by comparison of the stress-elongation behaviour. This can be assessed by corresponding tests on specimens from components which were previously exposed to these influences to a similar extent to that expected during the period of use of the roof kit. The properties established on these test specimens must again be considered in relation to the original properties and defined as a magnification or reduction factor (K_u , C_u). For the specification of ageing conditions see chapter 2.2.6.

2.2.5.3.3 Temperature Influences (K_θ , C_θ)

Depending on the type of load effect on the roof construction system, during use, both high and low temperatures can predominate. In general, for the plastics normally used at low temperatures, factors $K_\theta = C_\theta = 1.0$ can be selected. For higher temperatures, the reduction or magnification factors K_θ , C_θ can be derived from the stress-strain (Fig C.2.1) or the shear modulus curve (Fig C.2.2).

2.2.6 Durability

Durability of the translucent roof kit is evaluated according to EN 14963: 2006 clause 5.2.1 and 5.2.2. The ageing procedure shall be conducted in accordance with 6.2 of that standard. The classification is made in accordance with clause 5.2.2. The material classifications given in Table 1 of this section shall be declared in the ETA.

2.2.7 Resistance to damage by impact loads with a soft object (50 kg)

Resistance to damage by impact loads with a soft object (50 kg) shall be determined in accordance with EN 14963: 2006, clause 5.4.4.2 and clause 6.5.8. The roof kit shall be classified in accordance with tab.6. The test should be carried out analogously for flat kits.

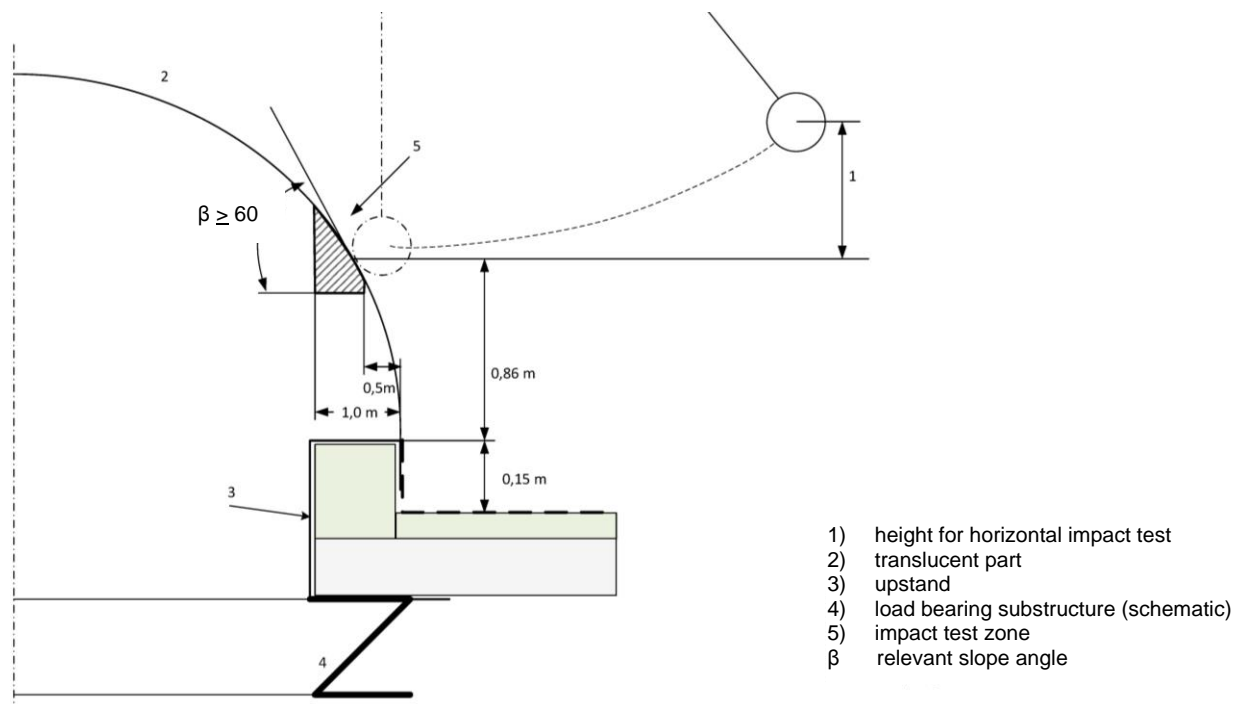


Figure 10: Horizontal impact test

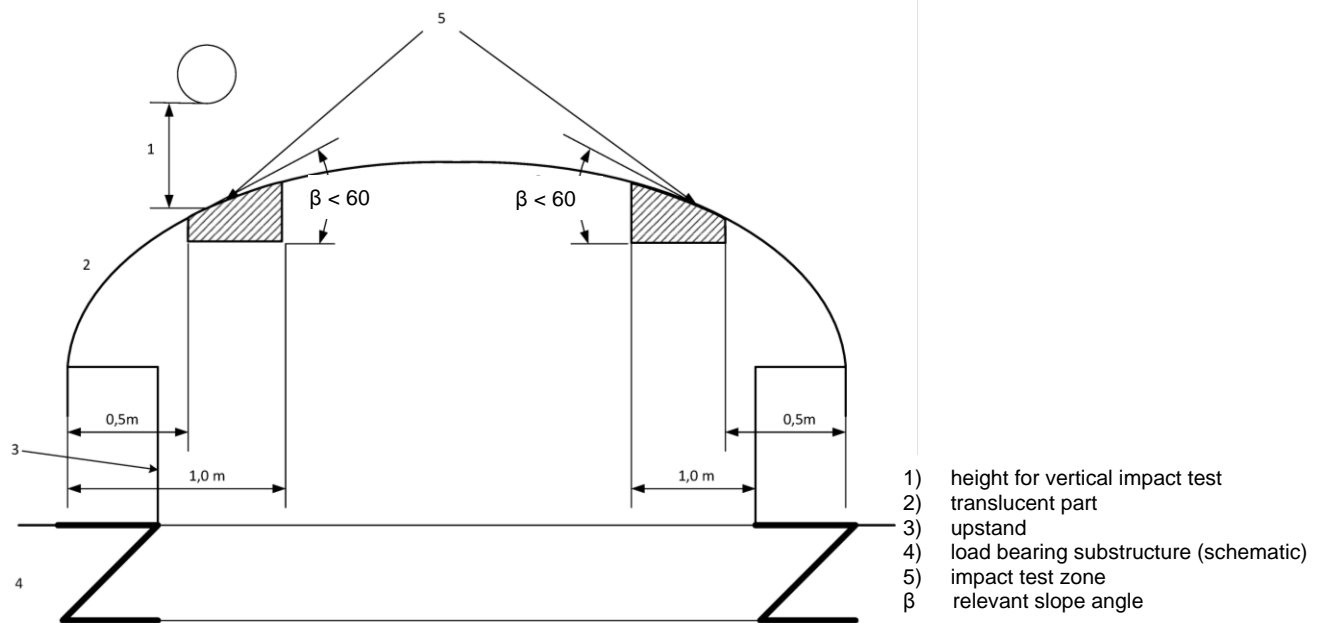


Figure 11: Vertical impact test

2.2.8 Resistance to impact loads from a hard object (250 g)

Resistance to impact loads from a hard object (250 g) shall be determined in accordance with EN 14963: 2006, clause 5.4.4.1 and clause 6.4.2.1. The performance is differentiated between passed or failed. If there is no visible damage the test specimen passed (e.g. according to EN 161533: 2013+A1:2015 the "failure occurs when a crack or a break appears on the test specimen"). If sheets with their own hEN are used, which includes the test of the resistance to impact loads from a hard object, then this hEN applies.

2.2.9 Airborne sound insulation

Airborne sound insulation is determined as sound reduction index R_w (C_{tr} , C) of the completely assembled kits in compliance with EN ISO 10140-1, 2, 4, 5. The size of the test sample and the mounting conditions shall conform to EN ISO 10140-1, Annex D.

For the evaluation of the results, the single value R_w (C; C_{tr}), in dB, shall be calculated according to EN ISO 717-1.

2.2.10 Thermal transmittance

The thermal transmittance U_r shall be determined in accordance with EN ISO 10077-1 as the resultant of the thermal transmittance coefficients of the covering, profiles, support structure, weighted on the basis of the areas as well as the length-weighted values of linear thermal transmittance coefficients of the connecting profiles.

The respective area fractions shall be calculated for the roof kits. For the calculation of the design value of the thermal transmittance coefficient U_r of the roof kits, the following equation shall be used:

$$U_r = \frac{\sum(U_{ti} \cdot A_{ti}) + \sum(U_{pi} \cdot A_{pi}) + \sum(U_{tg} \cdot A_{tg}) + \sum(\Psi_j \cdot l_j) + \sum(\Psi_g \cdot l_g)}{A_r} \text{ in } W/(m^2 \cdot K)$$

If the upstand to be taken into account, the following formula shall be used:

$$U_{rc} = \frac{\sum(U_{ti} \cdot A_{ti}) + \sum(U_{pi} \cdot A_{pi}) + \sum(U_{tg} \cdot A_{tg}) + \sum(U_{up} \cdot A_{up}) + \sum(\Psi_j \cdot l_j) + \sum(\Psi_g \cdot l_g) + \sum(\Psi_{up} \cdot l_{up})}{A_{rc}} \text{ in } W/(m^2 \cdot K)$$

where:

- U_{ti} : = thermal transmittance coefficient of the covering (translucent part) in $W/(m^2K)$
- A_{ti} : = area of the covering (translucent part) in m^2
- U_{pi} : = thermal transmittance coefficient of the covering, profiles, support structure [$W/(m^2K)$]
- A_{pi} : = area of the covering, profiles, support structure in m^2
- U_{tg} : = thermal transmittance coefficient of the gable (translucent part) in $W/(m^2K)$
- A_{tg} : = area of the gable (translucent part) in m^2
- U_{up} : = thermal transmittance coefficient of the upstand in $W/(m^2K)$
- A_{up} : = area of the upstand in m^2
- $\Psi_{g,j,up}$: = linear thermal transmittance coefficient at the level of the connecting profiles [$W/(m \cdot K)$]
- $l_{g,j,up}$: = connecting profile length in m
- A_r, A_{rc} : = total surface of the roof kits in m^2 (see envelope line).

In case the upstand is taken into the account $A_{rc} = A_r + A_{up}$ is valid.

1 = longitudinal limit of daylight size

See figure 12 and 13

In case the upstand is taken into account, the thermal transmittance U_z is either measured according to EN 12412-2 or calculated accordance to EN ISO 6946 for thermal homogenous design or according to EN ISO 10077-2 for kits with thermal bridges.

U_r, A_r for the roof kits shall be indicated in the ETA. If the rooflight system delivered with an upstand, the U_{rc}, A_{rc} must be specified.

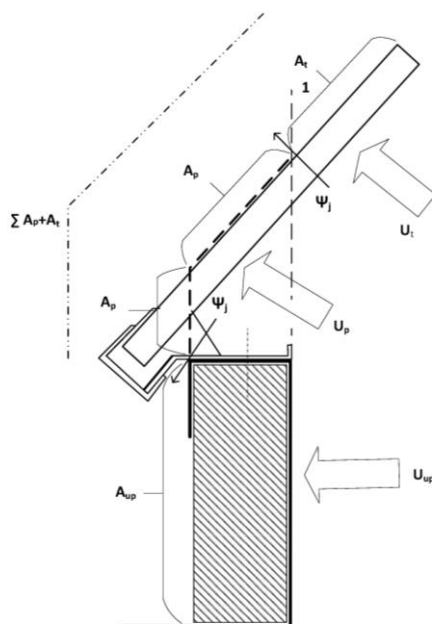


Figure 12: transversal section

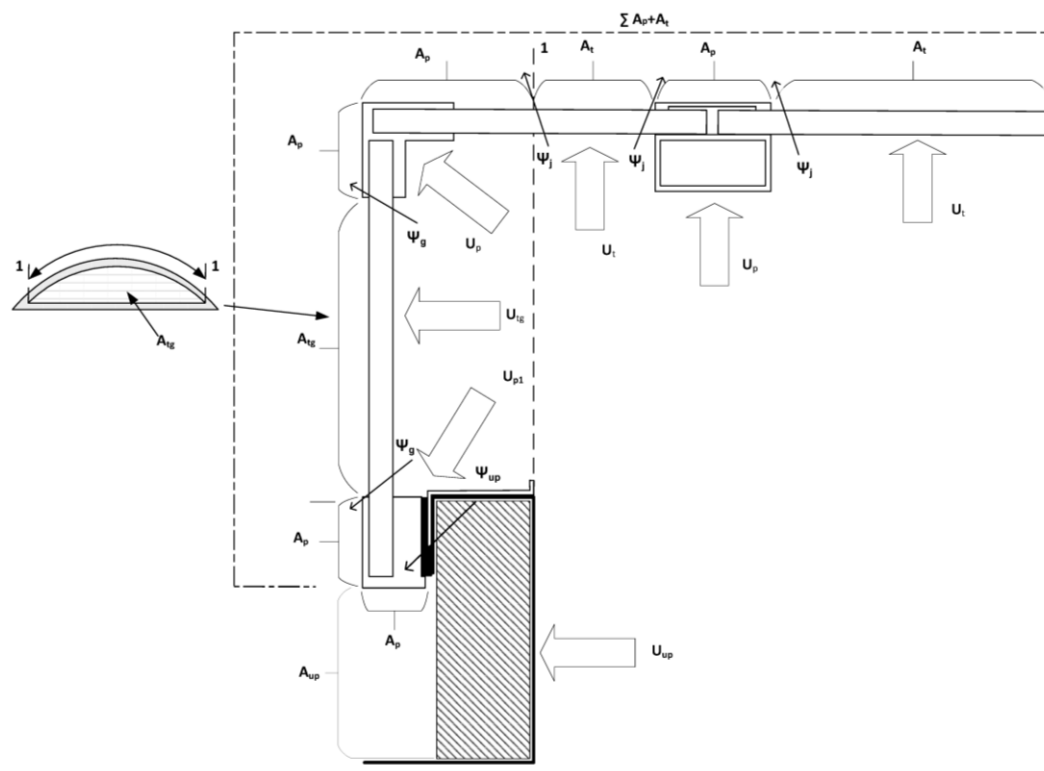


Figure 13: longitudinal section

2.2.11 Air permeability

Installed rooflights are tested in accordance with the following:

Test shall be carried out applying to the inside of the test specimen a series of positive pressures and measuring the air permeability in accordance with 2.2.11.1.

2.2.11.1 Test method for air permeability

To test the airtightness, the rooflights should be mounted on a practice-compliant construction (e. g. an upstand) in accordance with the manufacturer's instructions. The seal must be made according to the manufacturer's instructions.

This test is intended to judge the air tightness of rooflights by measuring the total amount of air passing through joints of a closed test specimen from inside to outside caused by the test pressure.

The amount of air shall be expressed in m^3/h .

The ambient temperature and humidity around the specimen shall be within the range of 19 °C to 27 °C and 25 % to 75 % RH and the specimen shall be conditioned thus for at least 4 h immediately before testing.

Temperature shall be measured to within ± 3 °C and relative humidity to within ± 5 %. Atmospheric pressure shall be measured to within ± 1 kPa.

The test pressure shall be applied with the following steps at 4 Pa, 10 Pa, 20 Pa, 30 Pa, 40 Pa, 50Pa, 75Pa and 100 Pa.

The air permeability result shall be given to an accuracy of 10 %.

The procedure to follow shall account for the air permeability of the test chamber

2.2.11.2 Test setup

The test setup consists of:

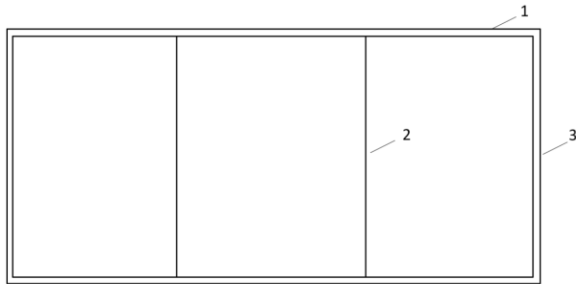
- A chamber with an open side on the top suitable to fit the test specimen. It shall be constructed so as to withstand the test pressures without deflecting to an extent likely to influence the test results.
- Means for applying controlled test pressure to test specimen.
- Means of producing rapid changes in test pressure, controlled within defined limits.

- Instrument suitable for measuring the quantity of air flow into or out of the chamber within an accuracy of $\pm 5\%$ (calibrated at $+20\text{ }^{\circ}\text{C}$, 101 kPa).
- Means of measuring the test pressure applied across the specimen, within an accuracy of $\pm 5\%$.
- Means of sealing all joints of the chamber test, when required.

2.2.11.3 Test specimen

A test on the rooflights including 3 typical rooflight elements (2 junctions) with the length of the perimeter $\geq 10\text{ m}$ can be considered to be representative of all continuous rooflights in a particular family range as defined in 2.2.11.3 (Fig. 14)

The test specimen shall include all typical joints of the rooflight construction for the family.



Key

- 1 perimeter of the rooflight (test specimen)
- 2 longitudinal junction part
- 3 Junction part at the gable end (if relevant)

Fig. 14: Test specimen of a typical continuous rooflight without openable parts

Typical joints of a continuous rooflight are:

- the joint to the upstand, if existing including the edge profiles,
- the junctions between the rooflight elements, including the junction parts, if existing,
- in case of gable ends the junctions between the gable end and the rooflight element,
- Joints of the edge profile due to the length of the rooflight.

When the rooflight family include also openable rooflight elements, an additional test shall be carried out on a test specimen of the same size (perimeter) including an openable element as indicated in Figure 15. The difference between the two measurements gives the influence of the openable part.

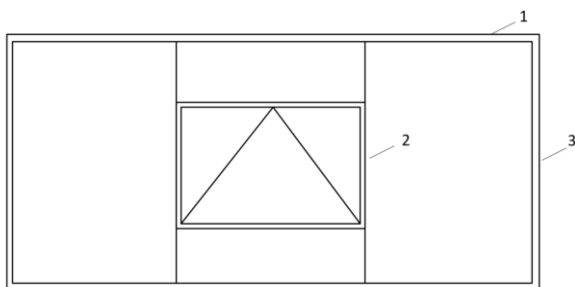


Fig. 15: Test specimen of a typical continuous rooflight with openable parts

2.2.11.4 Test procedure

Secure the test specimen on the top of the chamber as it would be on a roof in accordance with the manufacturer's instructions, without any twists or bends which may influence the test results. The specimen shall be fully operable.

The test specimen shall be cleaned with dry surfaces.

The rooflight shall be tested with a suitable substitute upstand.

If the rooflight is openable the test shall be carried out in the closed position

The air permeability of the test chamber shall be less than 5 % of the maximum air permeability permitted throughout the range of the classification that is attributed to the test specimen.

Note: A suitable means to measure air permeability of the chamber may be the test method indicated in EN 1026.

In the case of openable rooflights, open and close the openable part of the test specimen at least once before securing this in the closed position.

Apply three pressure pulses at 110 Pa. The time to reach the maximum test pressure shall be not less than 1 s and the pressure shall be sustained for at least 3 s.

Apply positive test pressure steps as specified in 2.2.11.1

Measure and record the total air flow at each step. The duration of each step shall be sufficient to allow the test pressure to stabilize before the air permeability is measured.

2.2.11.5 Evaluation of the results

Adjust the result of the air flow measurements (V_x) at each step, to calculate the air flow (V_o) under normal conditions ($T_o = 293$ K, $P_o = 101,3$ kPa), considering the actual temperature T_x , expressed in °C, and atmospheric pressure P_x , expressed in kPa, during the test.

$$V_o = V_x * \frac{293}{273 + T_x} * \frac{P_x}{101,3}$$

Calculate the air permeability in terms of m³/h/m, dividing the air flow volume (V_o) by the length of the perimeter of the continuous rooflight as defined in 2.2.11.3.

Record on a graph the air permeability for each pressure step.

For the measurement of the air permeability for 2 significant figures are used.

2.2.12 Radiation properties

The radiation properties are essentially characterized by the light transmittance τ_{D65} , the direct solar transmittance τ_e and the total solar energy transmittance g . For coverings consisting of only one sheet, the radiation properties of which are covered by a hEN, the value given by the sheet manufacturer shall be taken into account. In all other cases, the radiation properties of the cover shall be evaluated as follows.

The spectral characteristics of the transparent part of a continuous rooflight include the luminous and solar characteristics, and the reflection and transmission characteristics.

The characteristics are as follows:

- the spectral transmittance $\tau(\lambda)$ and the spectral reflectance $\rho(\lambda)$ in the wavelength range from 300 nm to 2450 nm;
- the light transmittance τ_{D65} and the light reflectance ρ_{D65} for standard illuminant D65;
- the total solar energy transmittance (solar factor) g .

The characteristics are determined for quasi-parallel, near normal radiation incidence using the radiation distribution of standard illuminant D65 (see EN 410, Table 1), solar radiation in accordance with EN 410 Table 2 and ultraviolet (UV) radiation in accordance with EN 410 Table 3.

2.2.12.1 Light transmission τ_{D65}

The light transmission, τ_{D65} , of the rooflight material is determined as total luminous transmittance of each skin and possible combinations of skins in new continuous rooflights.

The total luminous transmittance, τ_{D65} , for solid sheets can be determined by means of a photometer in accordance with EN ISO 13468-1 or EN ISO 13468-2.

The total luminous transmittance of multiwalled PC sheets is determined as luminous transmittance, τ_{D65} , by testing in accordance with EN 16153.

The total luminous transmittance of multiwalled PMMA sheets is determined as luminous transmittance, τ_A , by testing in accordance with EN ISO 12017, Annex A.

The total luminous transmittance of the combination of different material is calculated according to formulas given in EN 410.

For total luminous transmittance tests, one test per material type, colour type, thickness and manufacturer of plastic/resin is necessary.

2.2.12.2 Total solar energy transmittance g

The total solar energy transmittance, g [%] as defined in EN 410 shall be determined by calculation.

The calculation method is applicable only to transparent parts with symmetrical on-plan cross-section. Where the calculation method is not applicable, then the total solar energy transmittance shall be EN 161533: 2013+A1:2015 4.4 measured.

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 the applicable European legal act is Decision 98/600/EC.

The system is 3 for uses in roof and roof finishes except for uses subject to regulations on reaction to fire or on external fire performance.

For uses subject to regulations on reaction to fire the applicable AVCP systems are 1, 3 or 4 depending on the conditions defined in the Decision 98/600/EC.

For uses subject to regulations on external fire performance the applicable AVCP systems are 3 or 4 depending on the conditions defined in the Decision 98/600/EC.

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.

Table 3.2 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Reaction to fire	1. Product is in acc. with harmonized specification: DoP	class	all	Every delivery
		2. Product is not in acc. with harmonized specification:			
		Test method of manufacturer	Raw material and process control	As defined in the control plan	Every batch
		weight per unit area	As defined in the control plan		Continuously
		EN ISO 11925-2	Class acc. EN 13501-1	5	half yearly
2	External fire performance	CEN/TS 1187	Class acc. EN 13501-5	3	Initial start of production and every 5 years

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
3	Watertightness *	As defined in the control plan	As defined in the control plan	As defined in the control plan	As defined in the control plan
4	Load bearing capacity *				
5	Resistance to damage by impact loads with a soft object (50 kg) *				
6	Resistance to impact loads from a hard object (250 g) *				
7	Airborne sound insulation *				
8	Air permeability *				
9	Radiation properties *				

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.

The intervention of the notified body 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).

Table 3.3 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					
1	Initial inspection of the manufacturing plant and of factory production control carried out by the manufacturer considering the constancy of performances of reaction to fire and taking into account the limit of organic material and/or the addition of fire retardants.	As defined in the control plan	As defined in the control plan	–	When starting the production or a new production line
Continuous surveillance, assessment and evaluation of factory production control					
2	Continuous surveillance, assessment and evaluation of the factory production control carried out by the manufacturer considering the constancy of performances of reaction to fire and taking into account the limit of organic material and/or the addition of fire retardants.	As defined in the control plan	As defined in the control plan	As defined in the control plan	As defined in the control plan

3.4 Special methods of control and testing used for the assessment and verification of constancy of performance

3.4.1 Base components

The components shall be subject to control by the manufacturer before acceptance and agree with table 3.2. Check of the components shall include control of the inspection documents presented by the suppliers of the initial materials (comparison with nominal values or DoP).

3.4.1.1 Covering/ sheets

To ensure the constancy of the performance of coverings and sheets for use in roof kits, the relevant characteristics have to be determined, controlled and then regularly tested. For all base components that can be classified and used under the regulation of a harmonized European standard, the requirements, test methods and characteristics of this standard are to be used. Those values should be declared in a Declaration of Performance, as stated in the annex of the respective standard.

Any additional requirements of the roof kit that exceed the values determined according to the standard or that are not regulated or described in the standard may be subject to additional tests and assessments. These requirements are specified during the establishment of the control plan.

The tests can be done by either the manufacturer of the roof kit or by the supplier of the base components. The results of the factory production control have to be documented through suitable confirmations for each separate delivery. They range from the simple reception control of delivery papers, over a "Declaration of compliance with the order" to mechanical or chemical tests.

3.4.1.2 Aluminium profiles, sealing profiles etc

Material properties are to be proven regarding the accordance of delivered material with requested e.g. by an inspection certificate 3.1 according to EN 10204

The tolerances of the aluminium profiles shall be in accordance with EN 12020-2.

For roof kits with calculated bearing profiles according to 1.1 the load bearing components made of aluminium or steel including their fastenings shall be designed and produced in accordance with a factory production control system certified according to EN 1090-1.

4 REFERENCE DOCUMENTS

EN 13823:2010+A1:2014	Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item
EN 13501-1:2007+A1:2009	Fire classification of construction products and building elements; Part 1: Classification using test data from reaction to fire tests
EN 13501-5:2016	Fire classification of construction products and building elements; Part 5 Classification using data from external fire exposure to roof tests
EOTA TR 021:2005	Reaction to fire requirements for small components
EN 1026:2016	Windows and doors -Air permeability- Test method
EOTA TR 034:2015	General BWR3 Checklist for EADs/ETAs Content and/or release of dangerous substances in construction products
CEN/TS 16637-2:2014	Construction products - Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test
EN ISO 6341:2012	Water quality - Determination of the inhibition of the mobility of <i>Daphnia magna</i> Straus (Cladocera, Crustacea) - Acute toxicity test
ISO 15799:2003	Soil quality - Guidance on the ecotoxicological characterization of soils and soil materials
EN ISO 11348-1:2008	Water quality - Determination of the inhibitory effect of water samples on the light emission of <i>Vibrio fischeri</i> (Luminescent bacteria test) - Part 1: Method using freshly prepared bacteria
EN ISO 11348-2:2008	Water quality - Determination of the inhibitory effect of water samples on the light emission of <i>Vibrio fischeri</i> (Luminescent bacteria test) - Part 1: Method using liquid-dried bacteria
EN ISO 11348-3:2008	Water quality - Determination of the inhibitory effect of water samples on the light emission of <i>Vibrio fischeri</i> (Luminescent bacteria test) - Part 1: Method using freeze-dried bacteria
EN 1990: 2002 + A1:2005 + A1:2005/AC:2010	Basis of structural design
EN ISO 10140-1:2016	Acoustics - Laboratory measurement of sound insulation of building elements - Part 1: Application rules for specific products
EN ISO 717-1:2013	Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation
EN ISO 10077-1:2017	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 1: General
EN ISO 10077-2:2017	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames
EN ISO 6946:2017	Building components and building elements - Thermal resistance and thermal transmittance - Calculation methods
EN ISO 12412-2:2003	Thermal performance of windows, doors and shutters - Determination of thermal transmittance by hot box method - Part 2: Frames
EN 410:2011	Glass in building; Determination of luminous and solar characteristics of glazing

EN 1013: 2015	Light transmitting single skin profiled plastics sheets for internal and external roofs, walls and ceilings - Requirements and test methods
EN 161533: 2013 +A1:2015	Light transmitting flat multiwall polycarbonate (PC) sheets for internal and external use in roofs, walls and ceilings - Requirements and test methods
EN 16240: 2014	Light transmitting flat solid polycarbonate (PC) sheets for internal and external use in roofs, walls and ceilings - Requirements and test methods
EN 14024:2004	Metal profiles with thermal barrier - Mechanical performance - Requirements, proof and tests for assessment
EN 14963: 2006	Roof coverings - Continuous rooflights of plastics with or without upstands - Classification, requirements and test methods
EN ISO 291:2008	Plastics - Standard atmospheres for conditioning and testing
EN ISO 13468-1:1996	Plastics - Determination of the total luminous transmittance of transparent materials - Part 1: Single-beam instrument
EN ISO 13468-2:2006	Plastics - Determination of the total luminous transmittance of transparent materials - Part 2: Double-beam instrument
EN 10204:2004	Metallic products - Types of inspection documents
EN 1090-1:2012	Execution of steel structures and aluminium structures; Requirements for conformity assessment of structural components
EN 12020-2:2016+AC:2017	Aluminium and aluminium alloys - Extruded precision profiles in alloys EN AW-6060 and EN AW-6063 - Part 2: Tolerances on dimensions and form
EN ISO 12017:1996	Plastics - Poly(methyl methacrylate) double- and triple-skin sheets - Test methods (ISO 12017:1995)
EN ISO 899-2:2003+A1: 2015	Plastics - Determination of creep behaviour - Part 2: Flexural creep by three-point loading (ISO 899-2:2003 + Amd.1:2015)
EN ISO 527:2012	Plastics - Determination of tensile properties
EN ISO 6721:1996	Plastics - Determination of dynamic mechanical properties

ANNEX A: EXAMPLES OF ROOF KITS

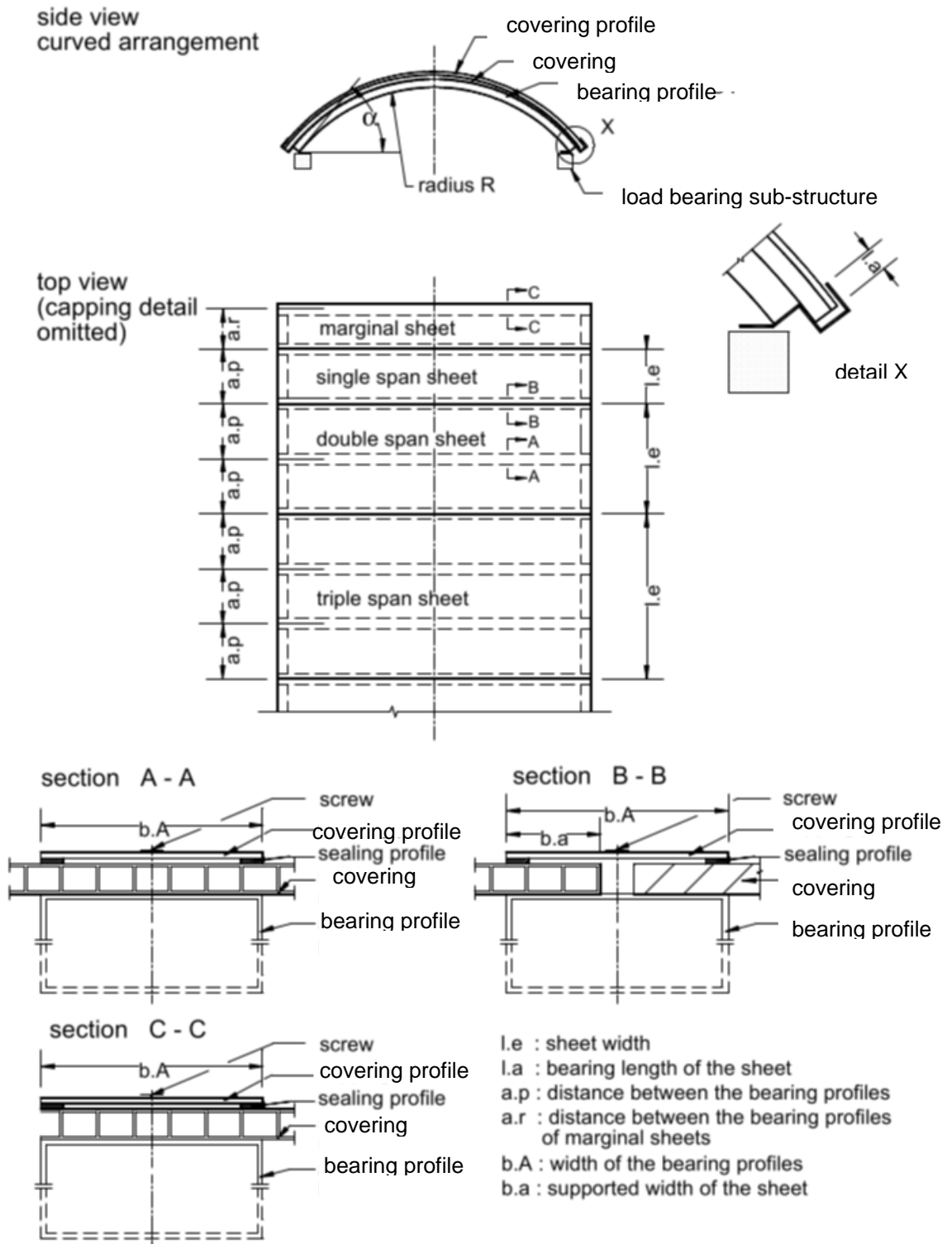


Fig. A.1: Example of a curved roof kit with bearing profiles sheet in single, double and triple span arrangement

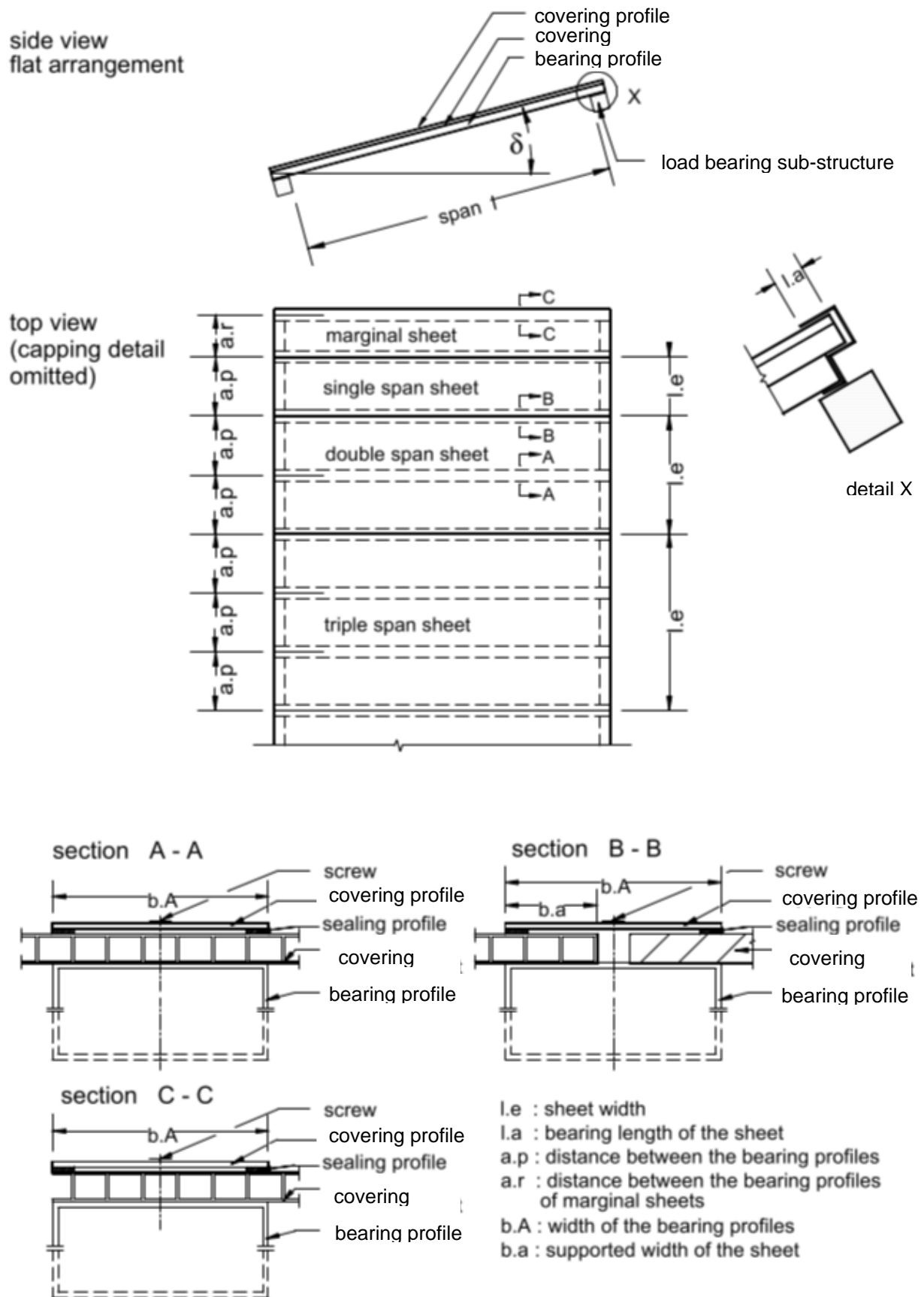


Fig. A.2: Example of a flat roof kit with bearing profiles sheet in single, double and triple span system

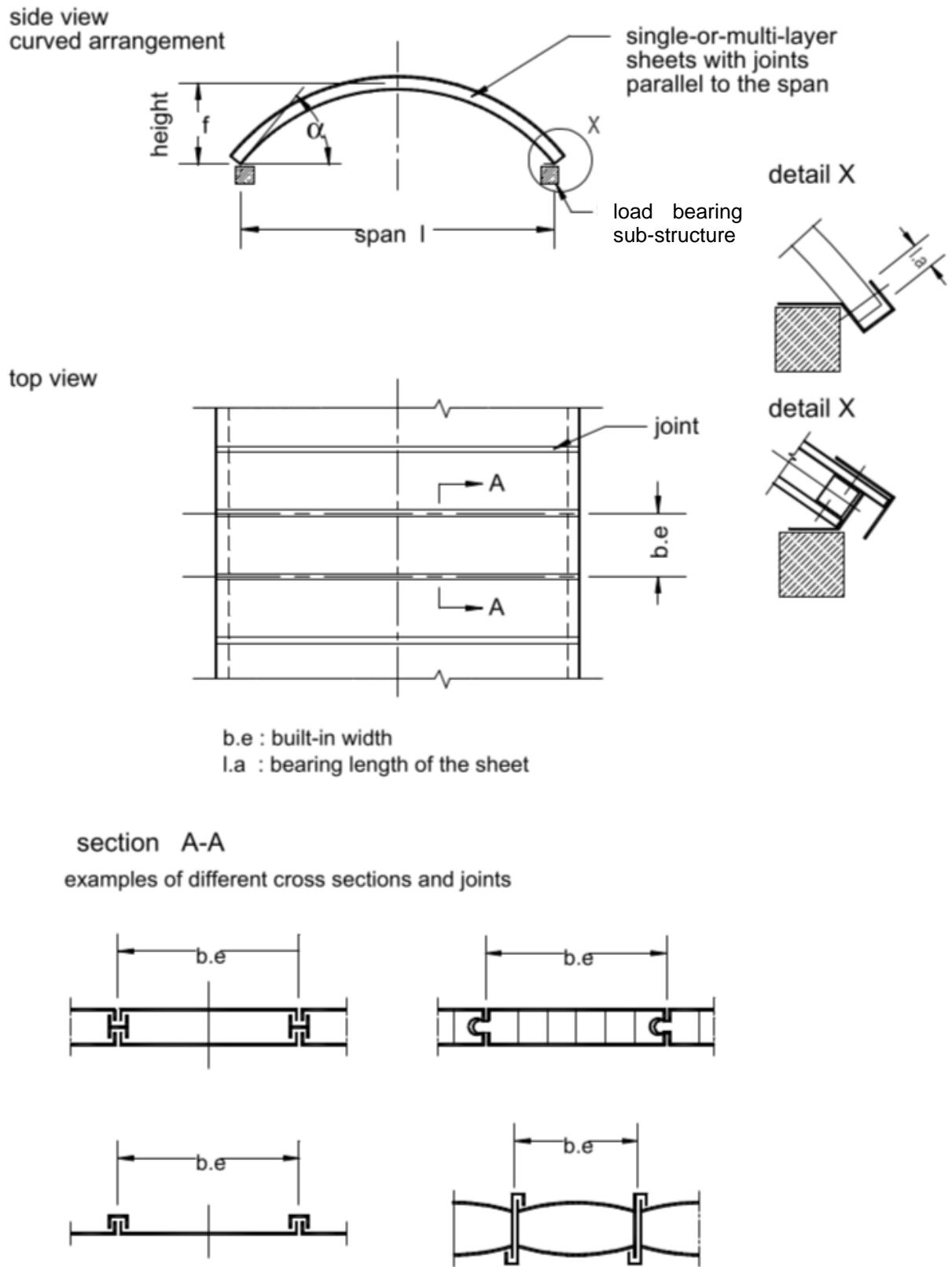
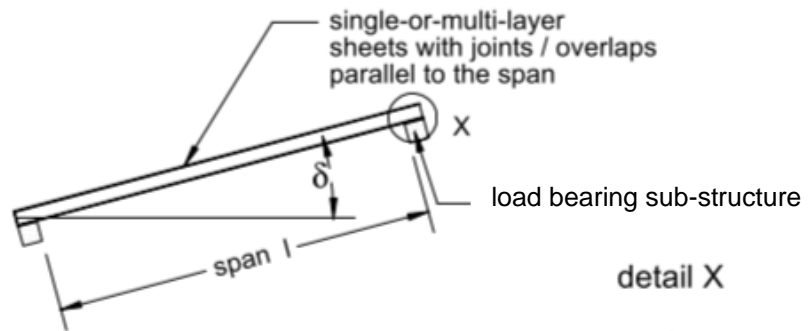
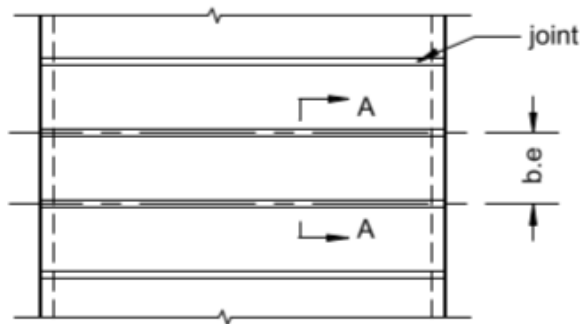


Fig. A.3: Example of a curved roof kit without bearing profiles

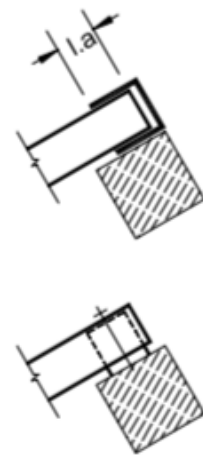
side view
flat arrangement



top view



detail X



b.e : built-in width
l.a : bearing length of the sheet

section A-A

examples for different cross sections

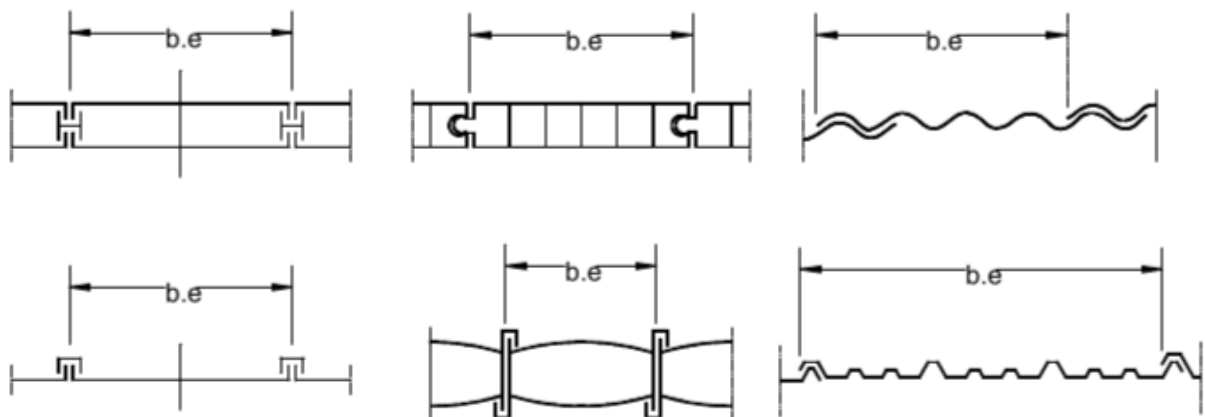


Fig. A.4.1: Example of a flat roof kit without bearing profiles single span system

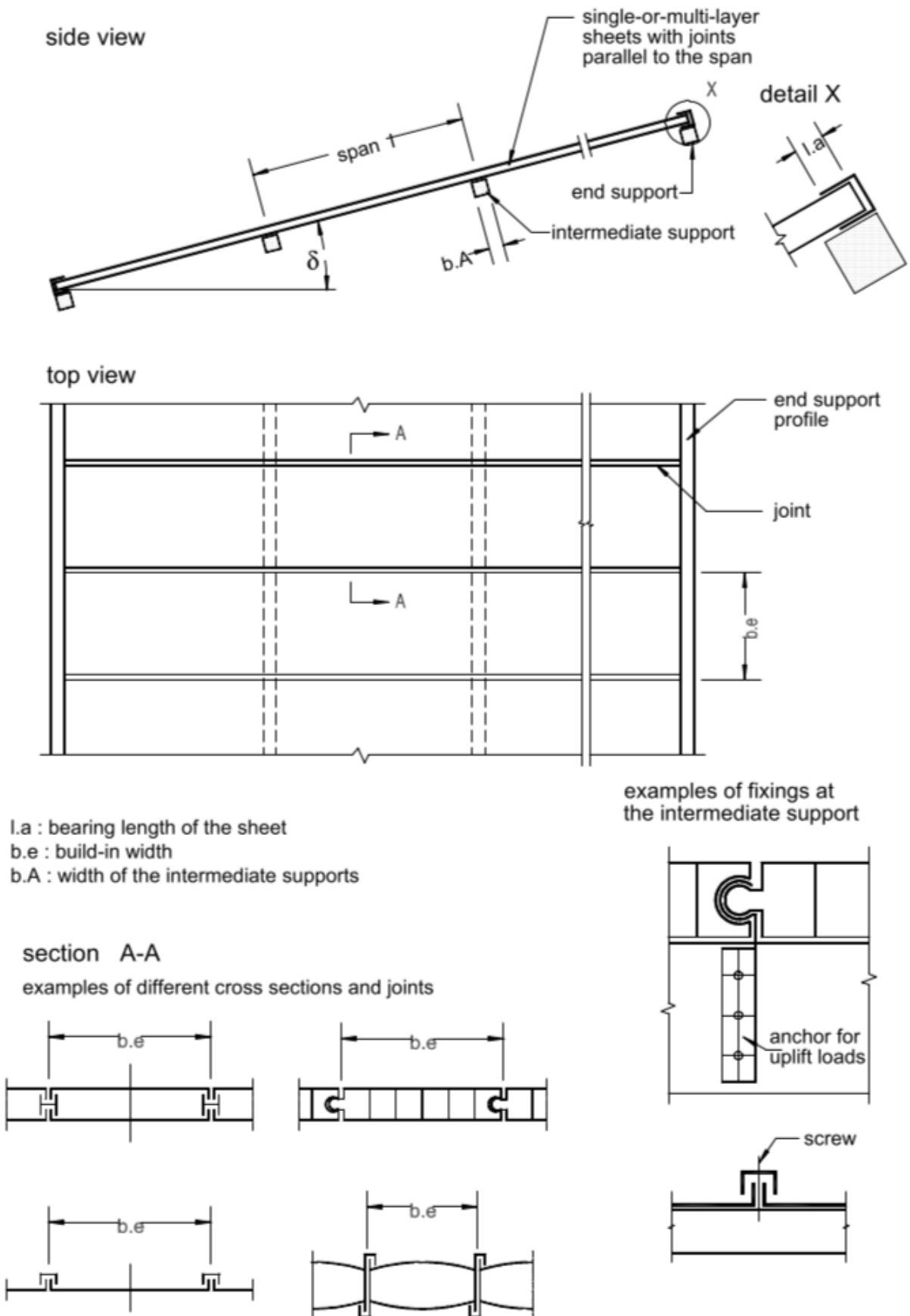


Fig. A.4.2: Example of a flat roof kit without bearing profiles and sheets with longitudinal connectors multi span system

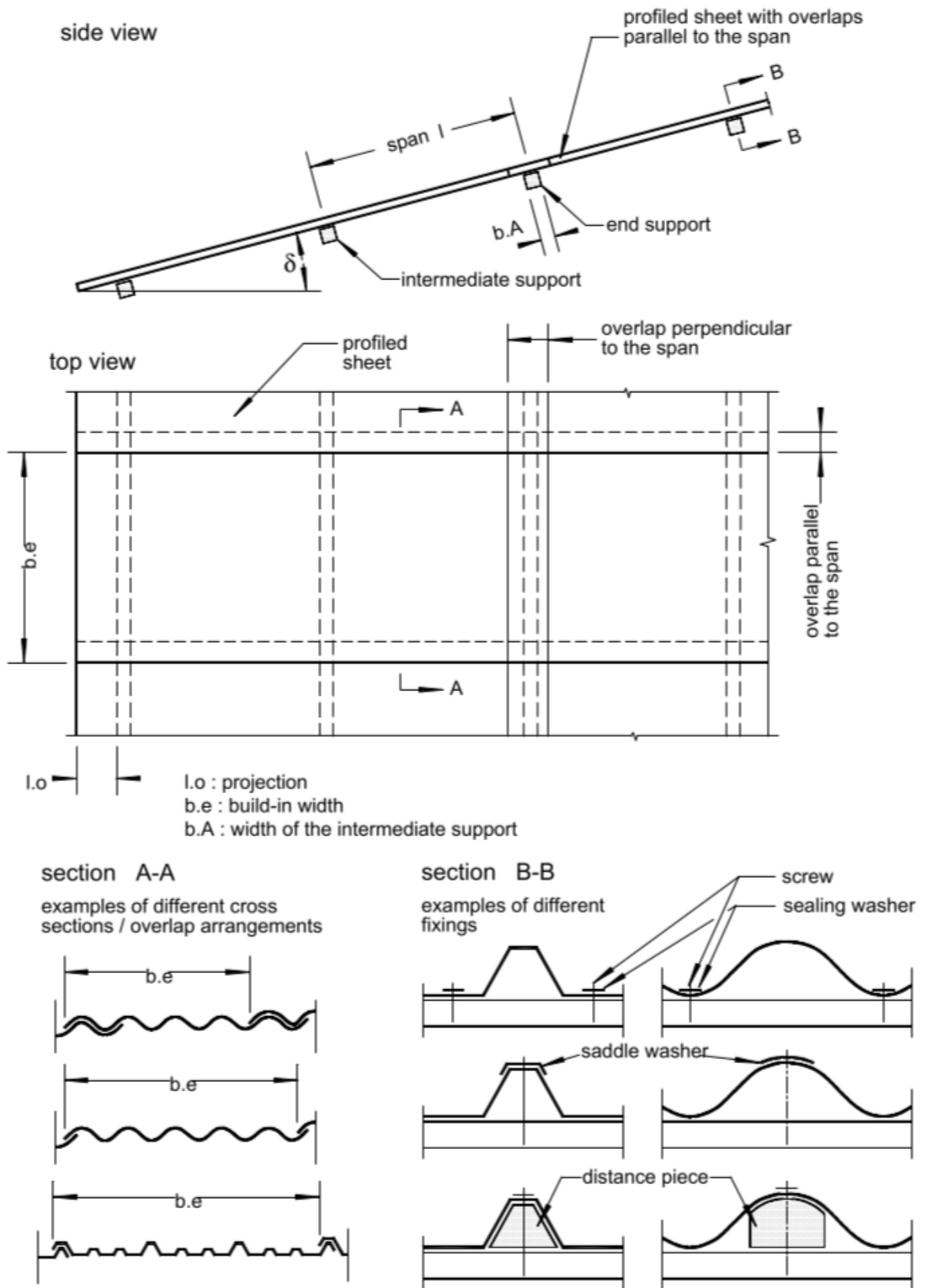
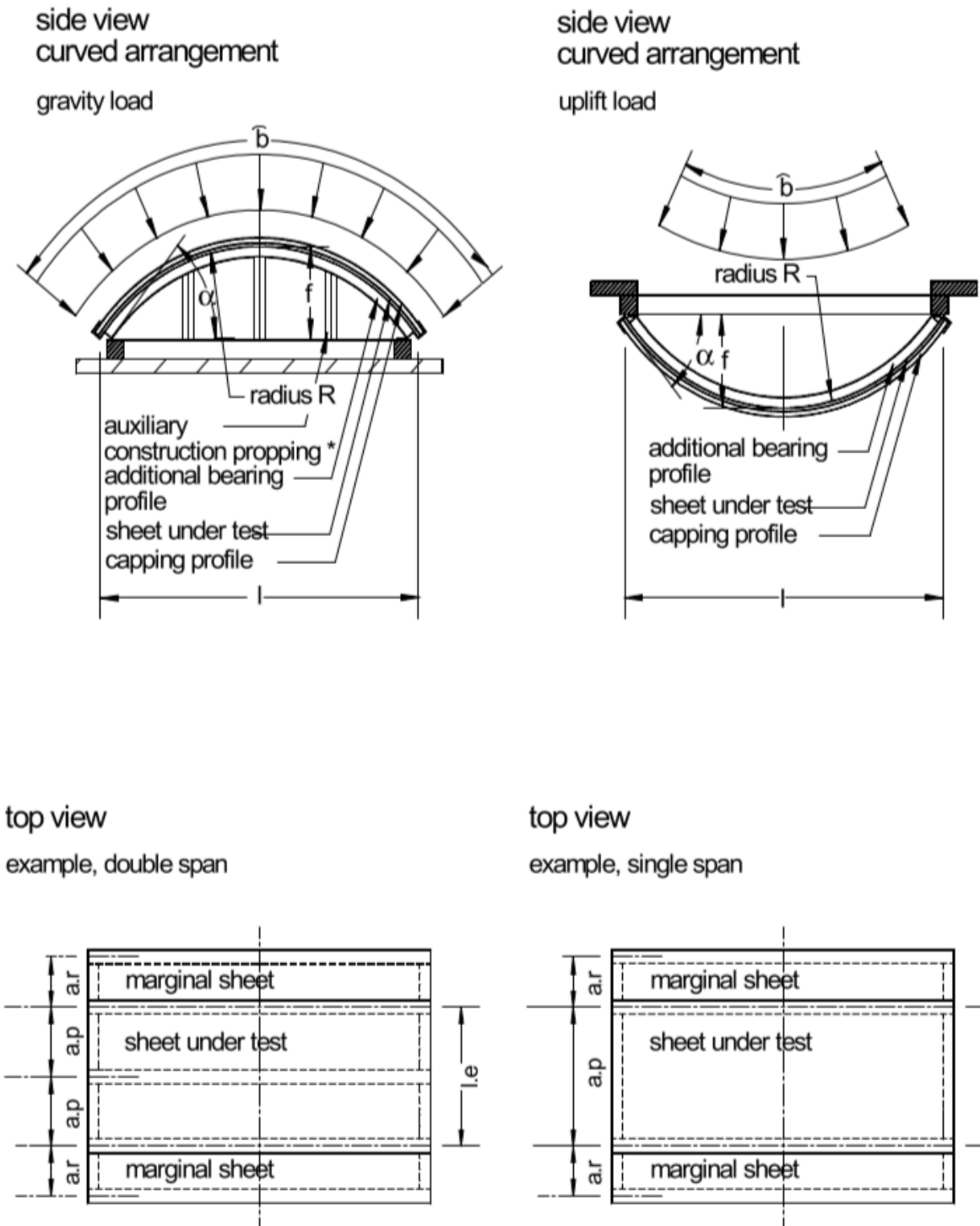


Fig. A.4.3: Example of a flat roof kit without bearing profiles and corrugated sheets multi span system

ANNEX B: TEST SETUPS FOR FULLSCALE TESTING



When the whole assembly is tested, no propping is used.

* For use only where the sheet is under test.

Fig. B.1: Test setup (schematic), downward load and upward load for curved systems with bearing profiles

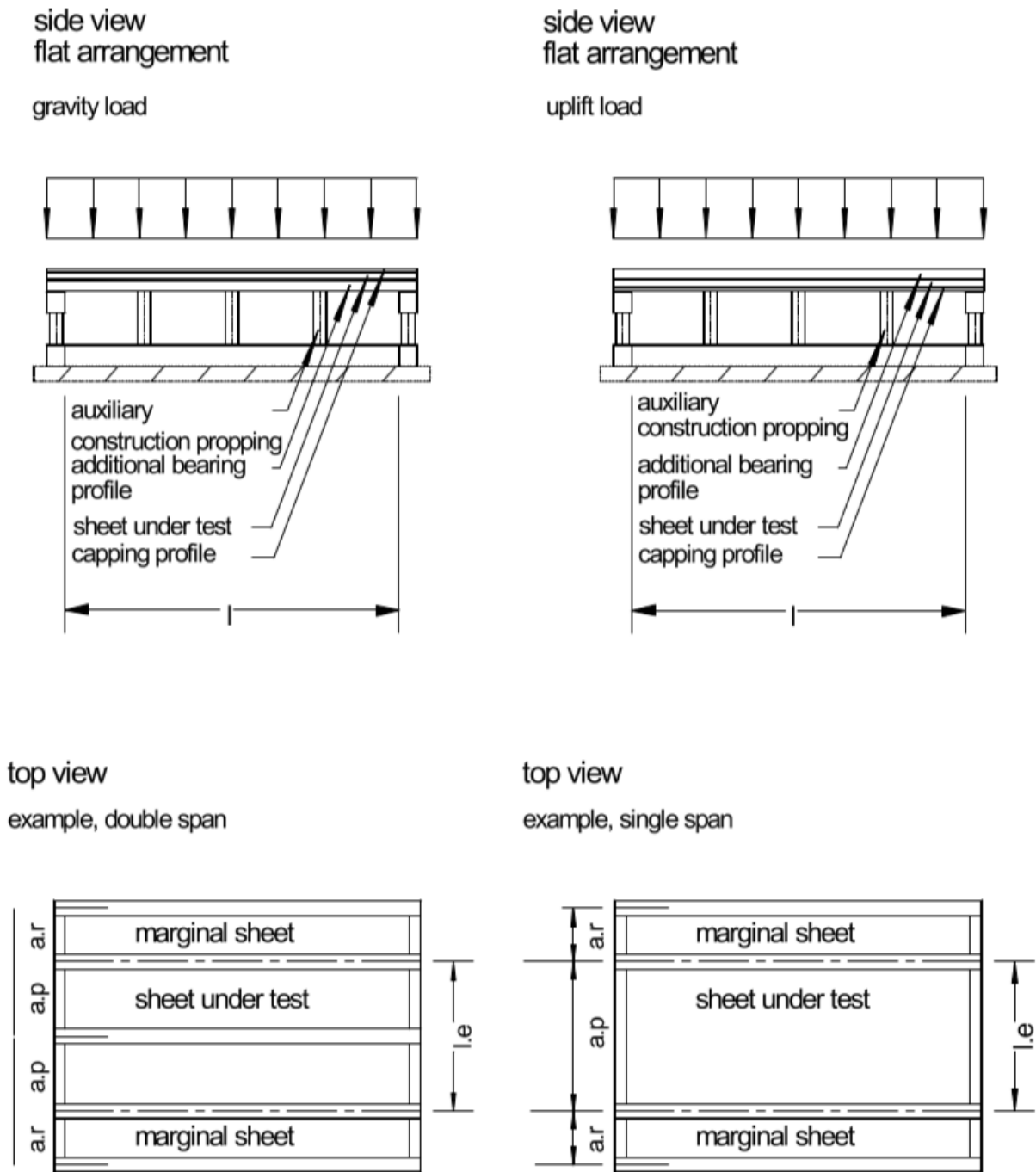
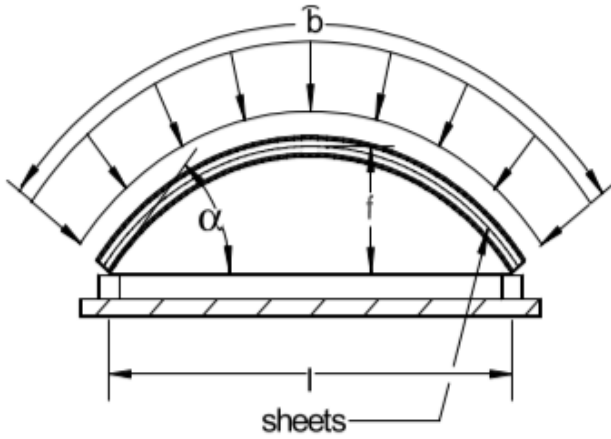
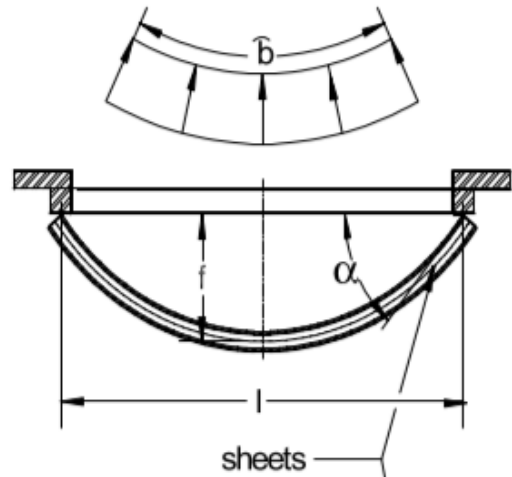


Fig. B.2: Test setup (schematic), downward load and upward load for flat systems with bearing profiles

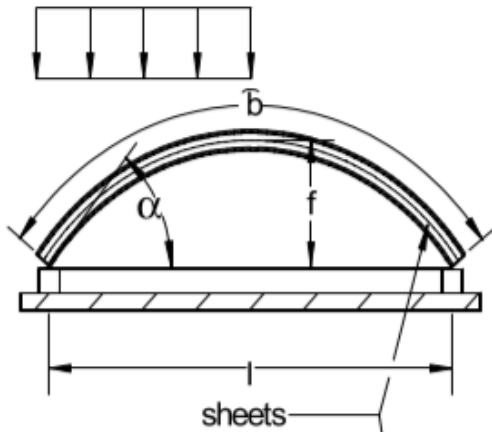
side view curved arrangement
gravity load, full load



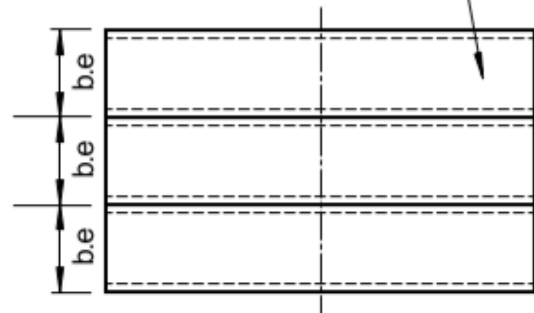
side view curved arrangement
uplift load



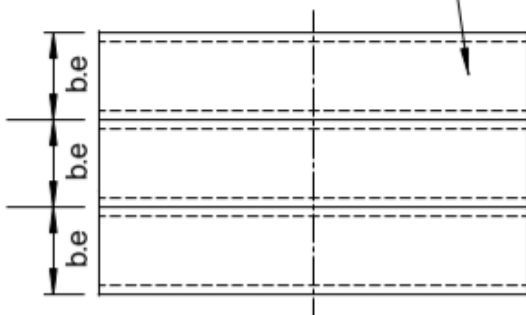
side view curved arrangement
gravity load, half-span load



top view

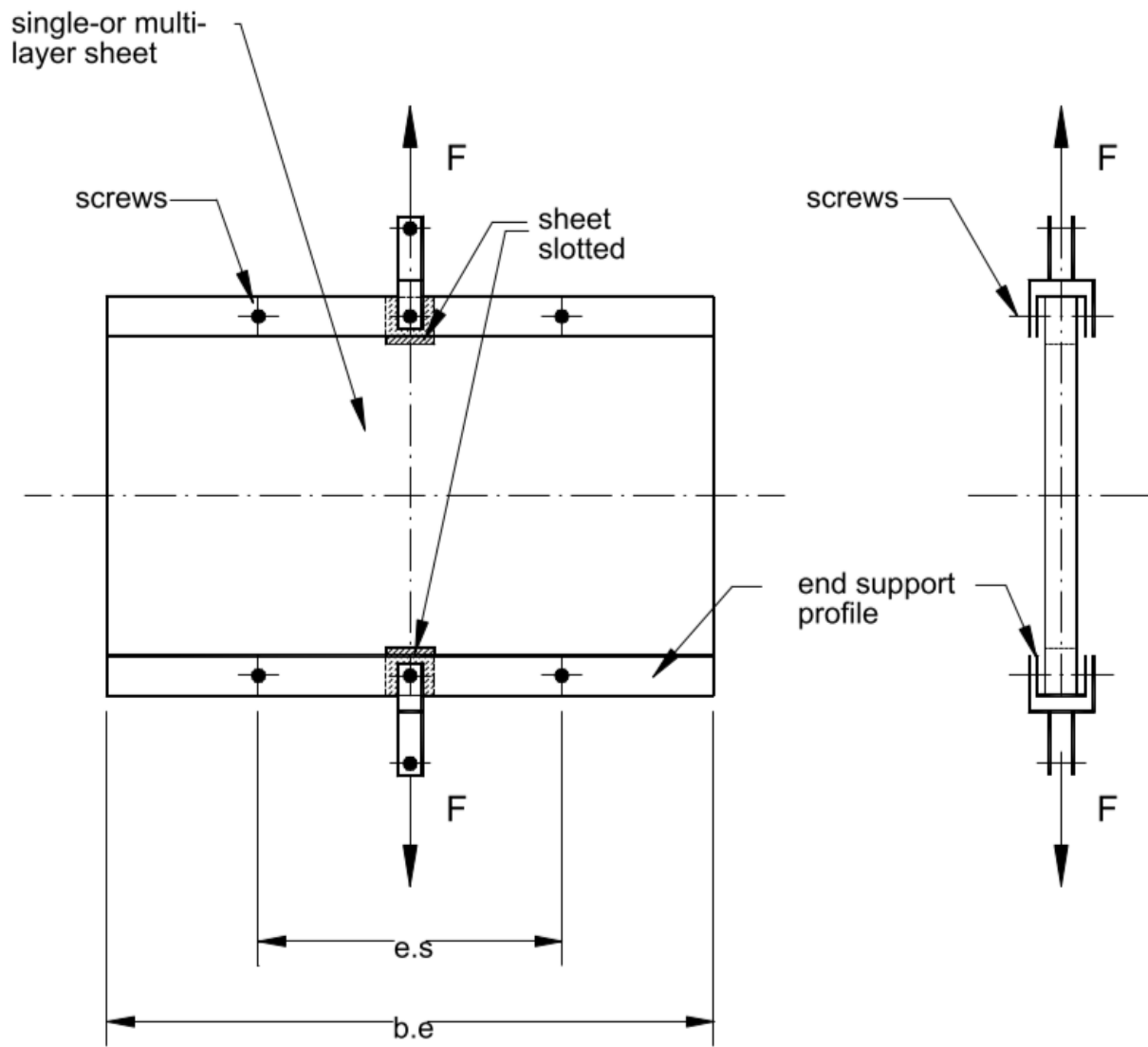


top view



If the support fixing is significant the test structure may be chosen as for figure B.3.2

Fig. B.3.1: Test setup (schematic), downward load and upward load for curved systems without bearing profiles



$e.s$: distance between the screws

Fig. B.3.2: alternative tension test setup on the support profiles (schematic), upward load for curved systems without bearing profiles

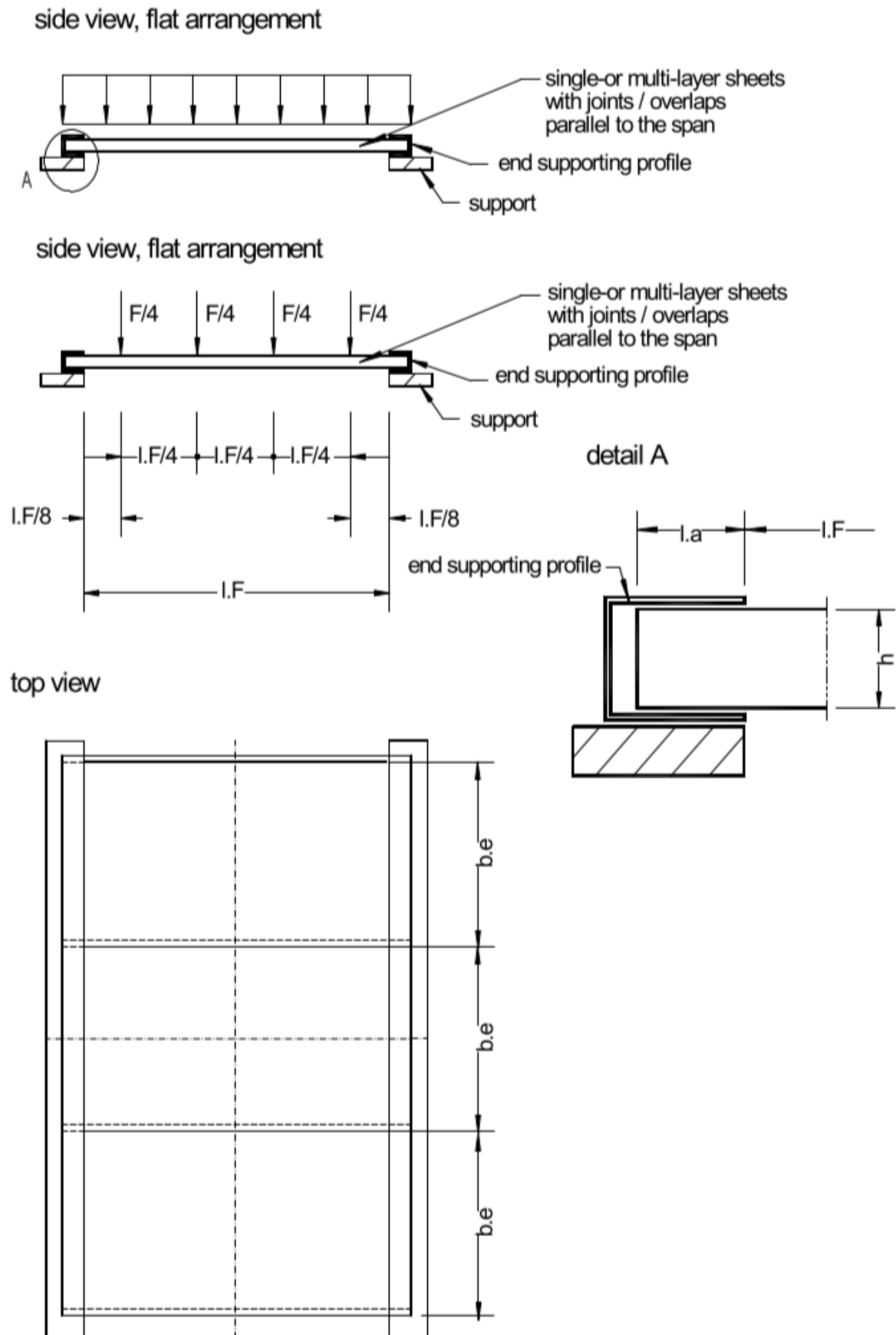


Fig. B.4.1.1: test setup (schematic), downward load and upward load for flat systems without bearing profiles, single span systems for sheets with longitudinal joints

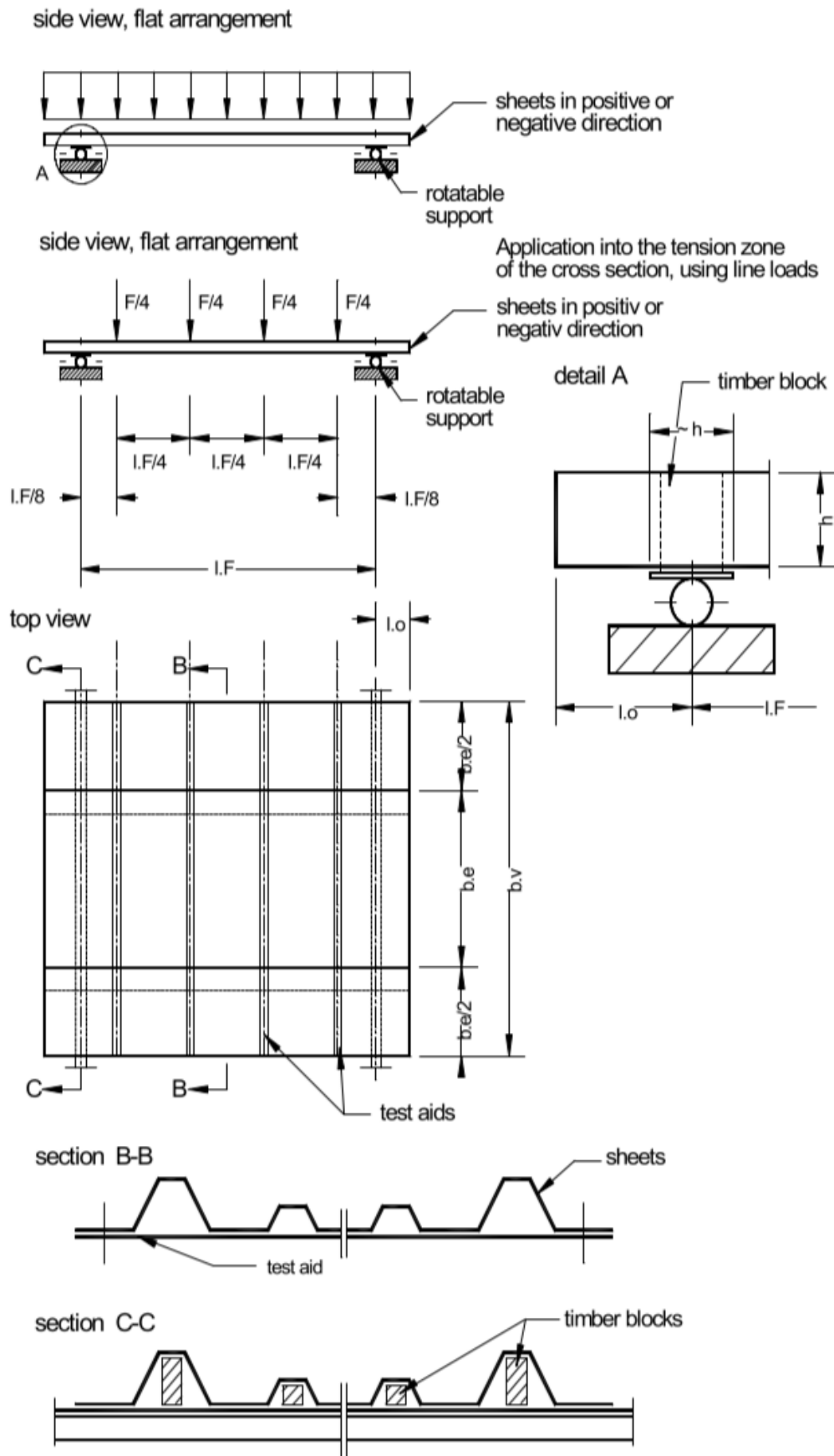


Fig. B.4.1.2: test setup (schematic), downward load and upward load for flat systems without bearing profiles, single span systems for sheets with overlaps (see Eurocode 3)

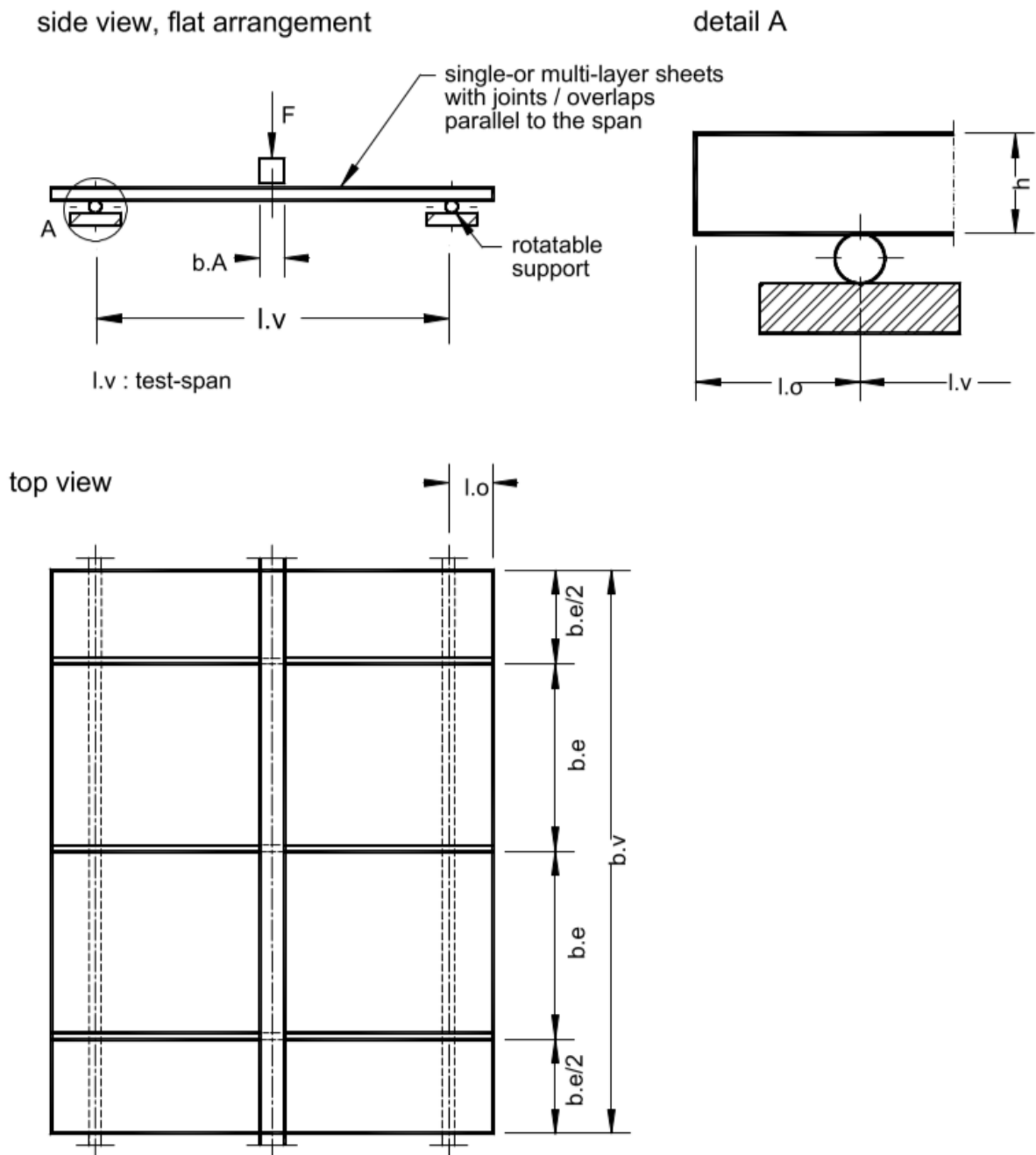


Fig. B.4.2.1: test setup (schematic) for flat systems without bearing profiles to determine the interaction at the intermediate support for downward load, multi span systems for sheets with longitudinal joints (see Eurocode 3)

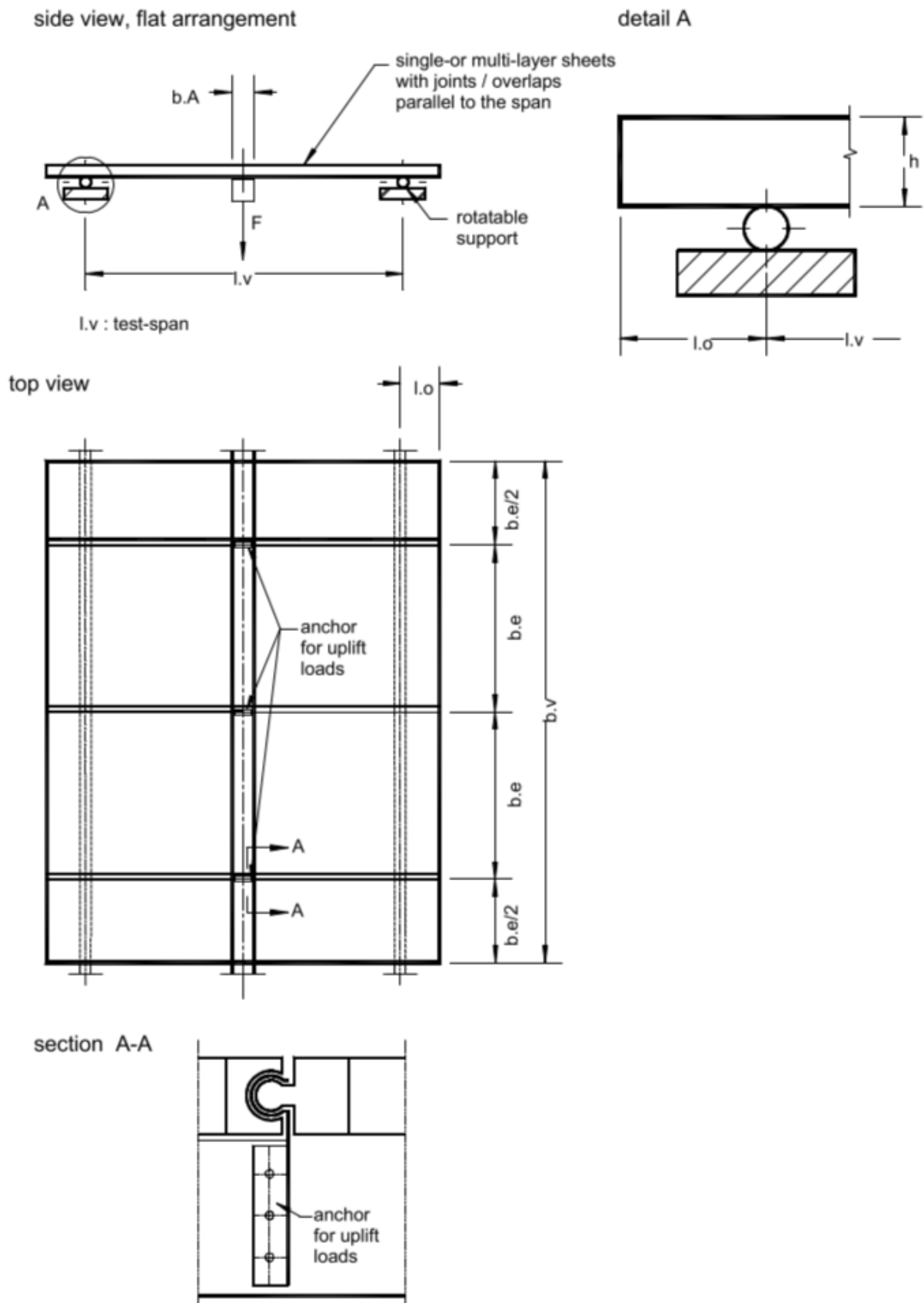


Fig. B.4.2.2: test setup (schematic) for flat systems without bearing profiles to determine the interaction at the intermediate support for upward load, multi span systems for sheets with longitudinal joints (see Eurocode 3)

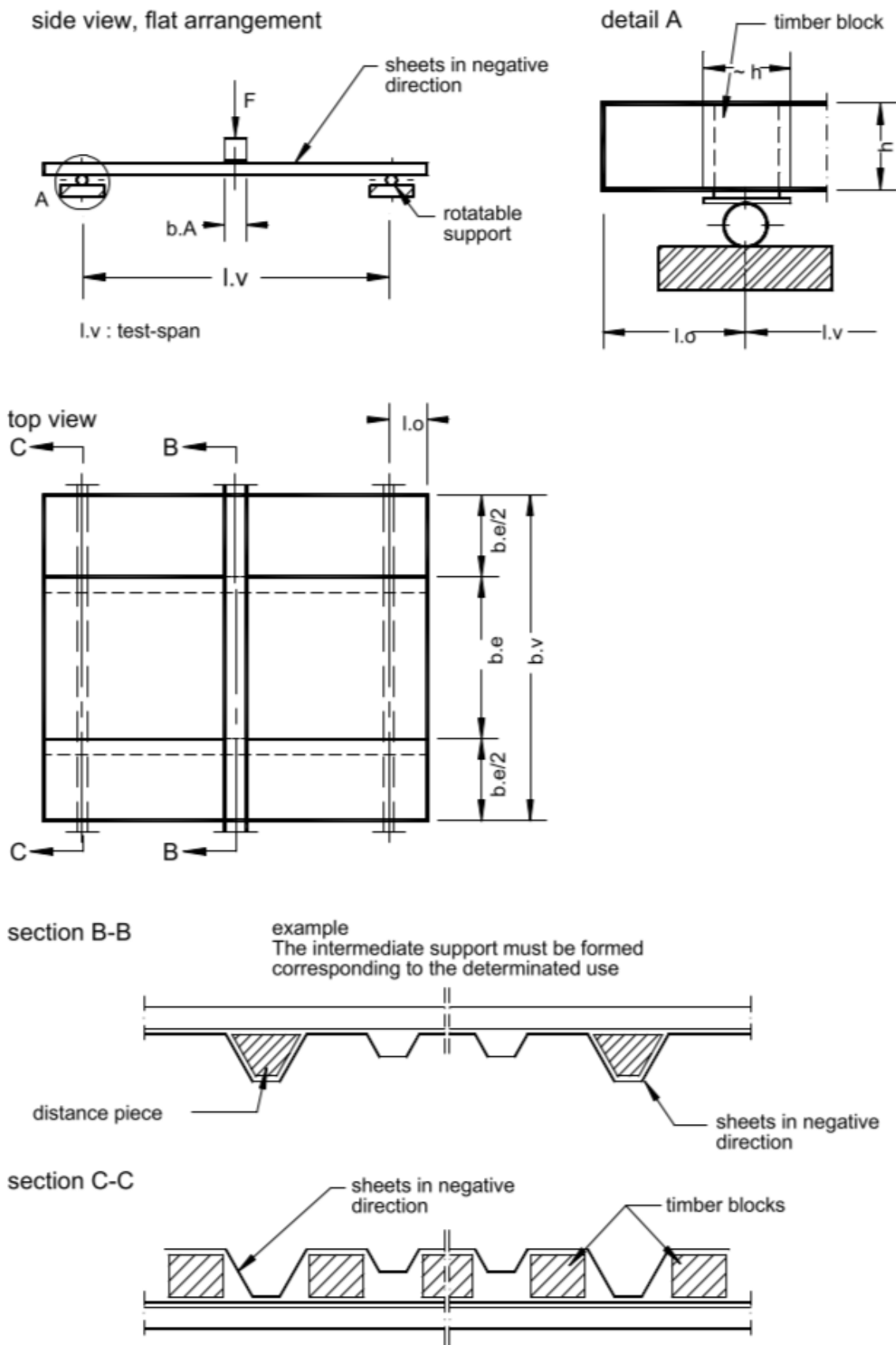


Fig. B.4.3.1: test setup (schematic) for flat systems without bearing profiles to determine the interaction at the intermediate support for downward load, multi span systems for sheets with overlaps (see Eurocode 3)

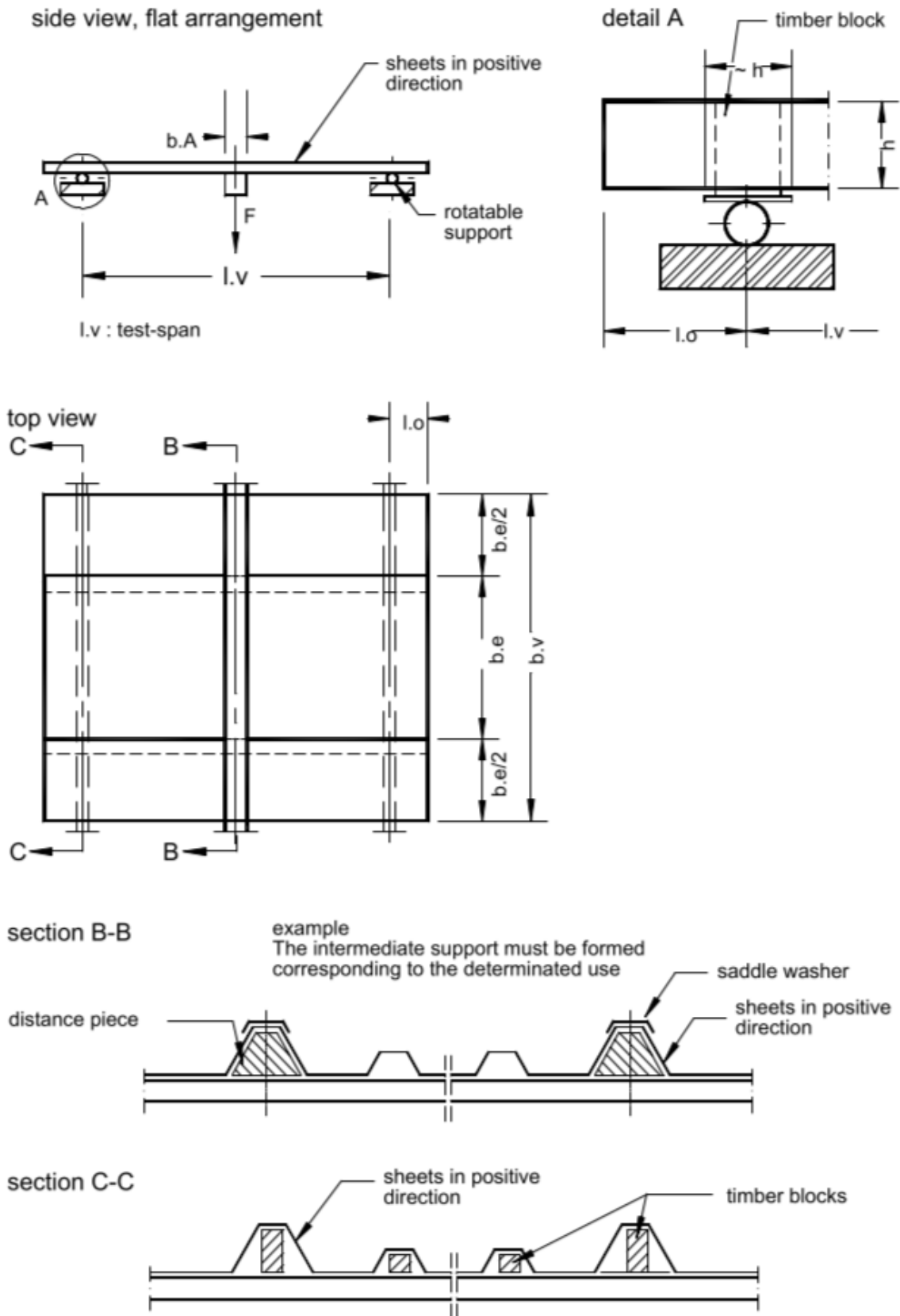


Fig. B.4.3.2: test setup (schematic) for flat systems without bearing profiles to determine the interaction at the intermediate support for upward load, multi span systems for sheets with overlaps (see Eurocode 3)

ANNEX C: EXAMPLES FOR DETERMINATION OF THE MATERIAL DEPENDENT INFLUENCE FACTORS

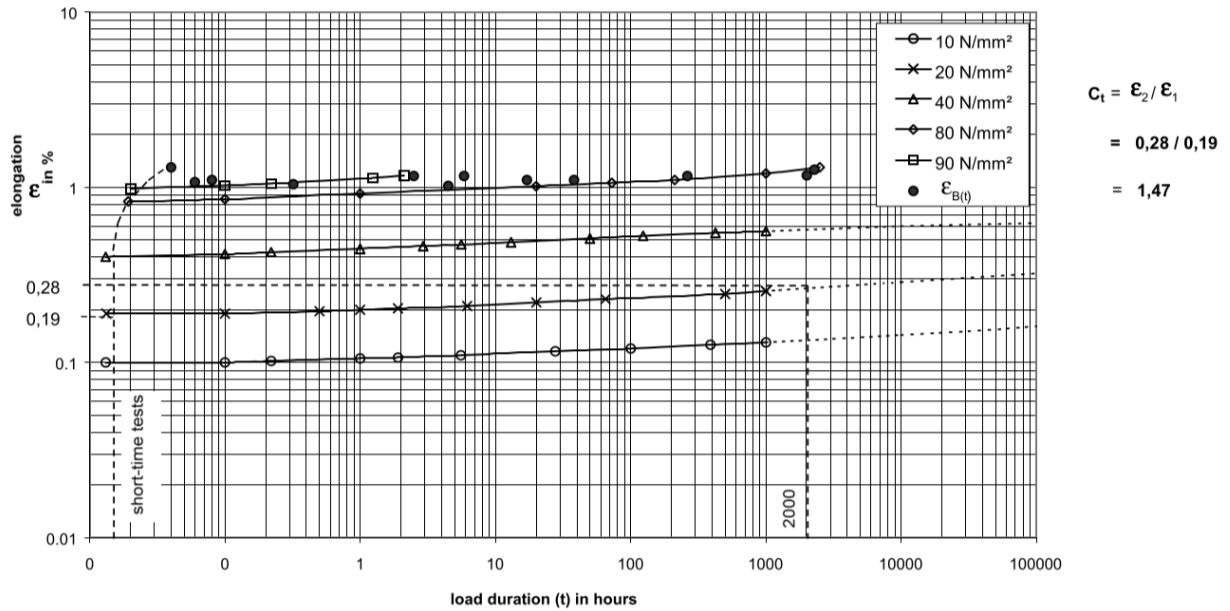


Fig. C.1.1: Time-elongation- curves for glass-reinforced unsaturated polyester resin with 30% glass mass content (copped strand mats = CSM)

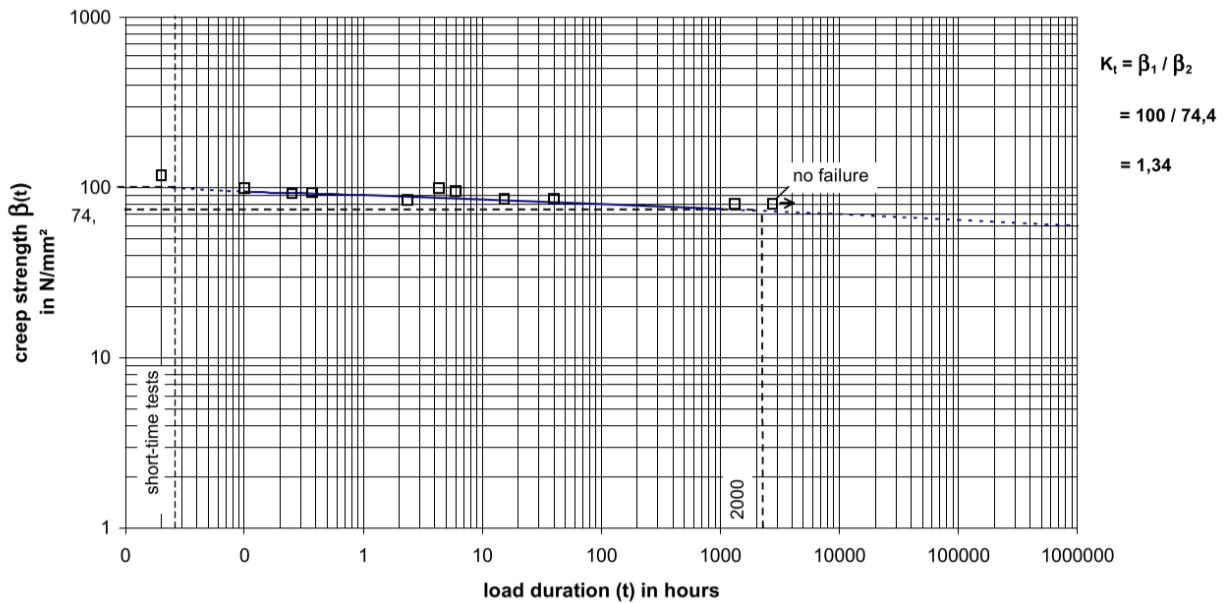


Fig. C.1.2: Time-strength-curves for glass-reinforced unsaturated polyester resin with 30% glass mass content (copped strand mats = CSM)

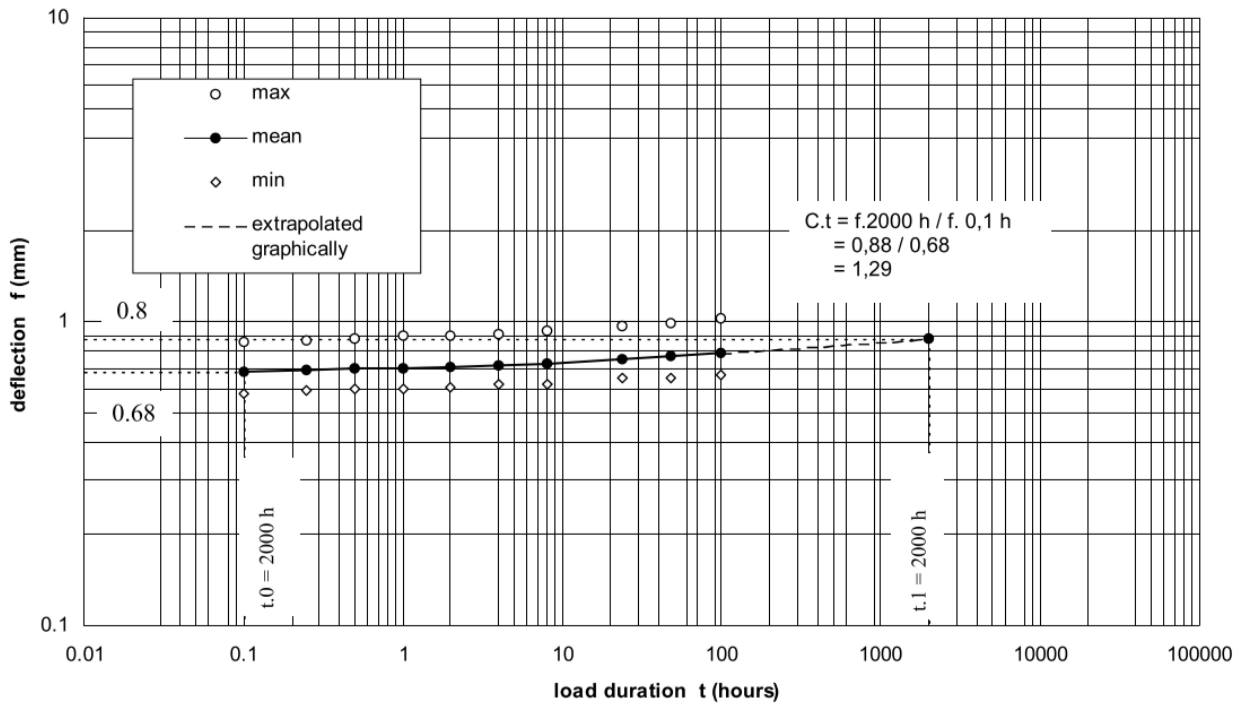


Fig. C.1.3: Time-deflection-curves for a solid sheet of PMMA tests according EN 16240

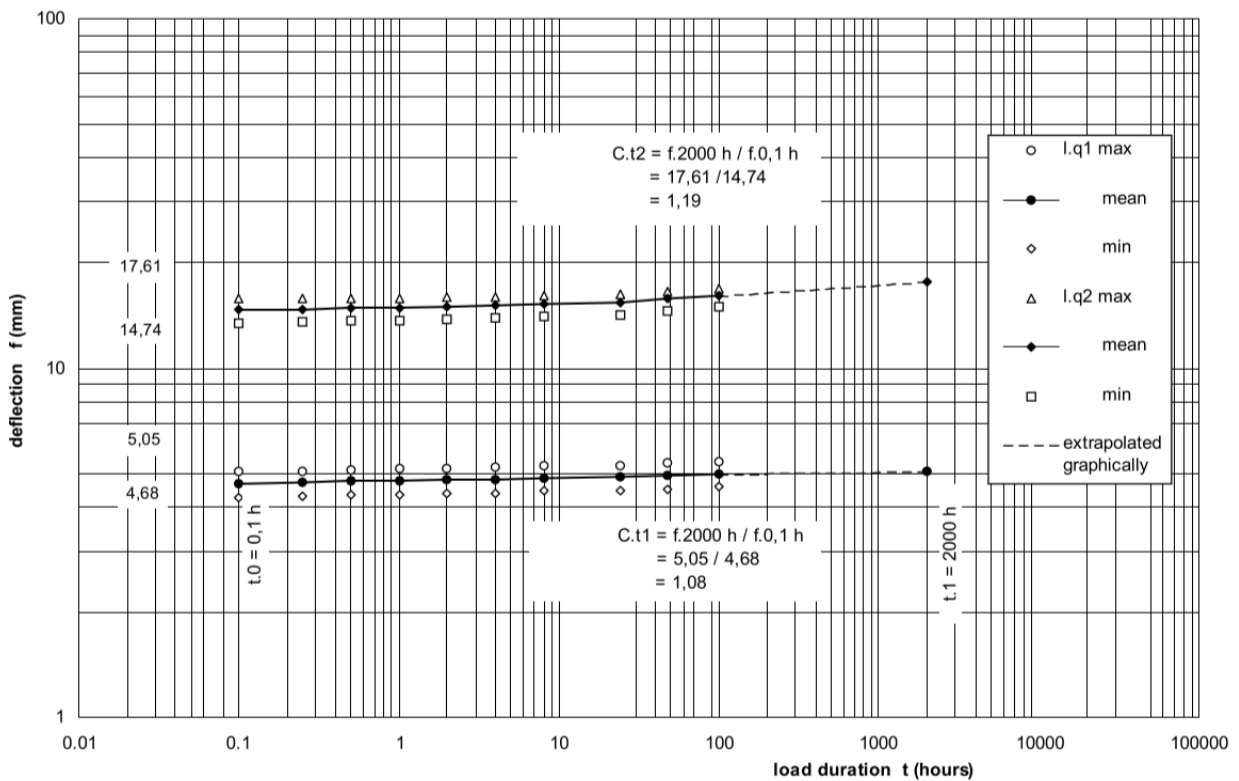


Fig. C.1.4: Time-deflection-curves for a multi-wall sheet of PVC tested according EN 161533: 2013+A1:2015 with two different spans

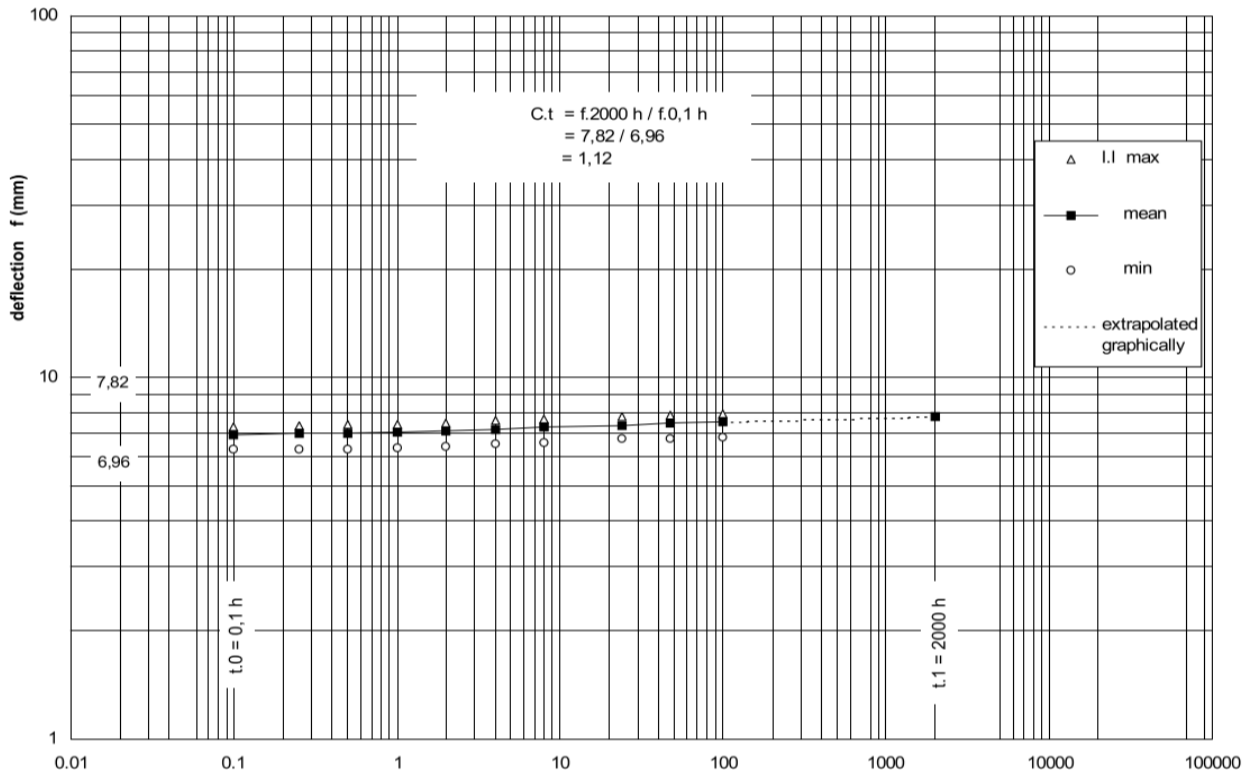


Fig. C.1.5: Time-deflection-curves for a multi-wall sheet of PC tested according EN 161533: 2013+A1:2015

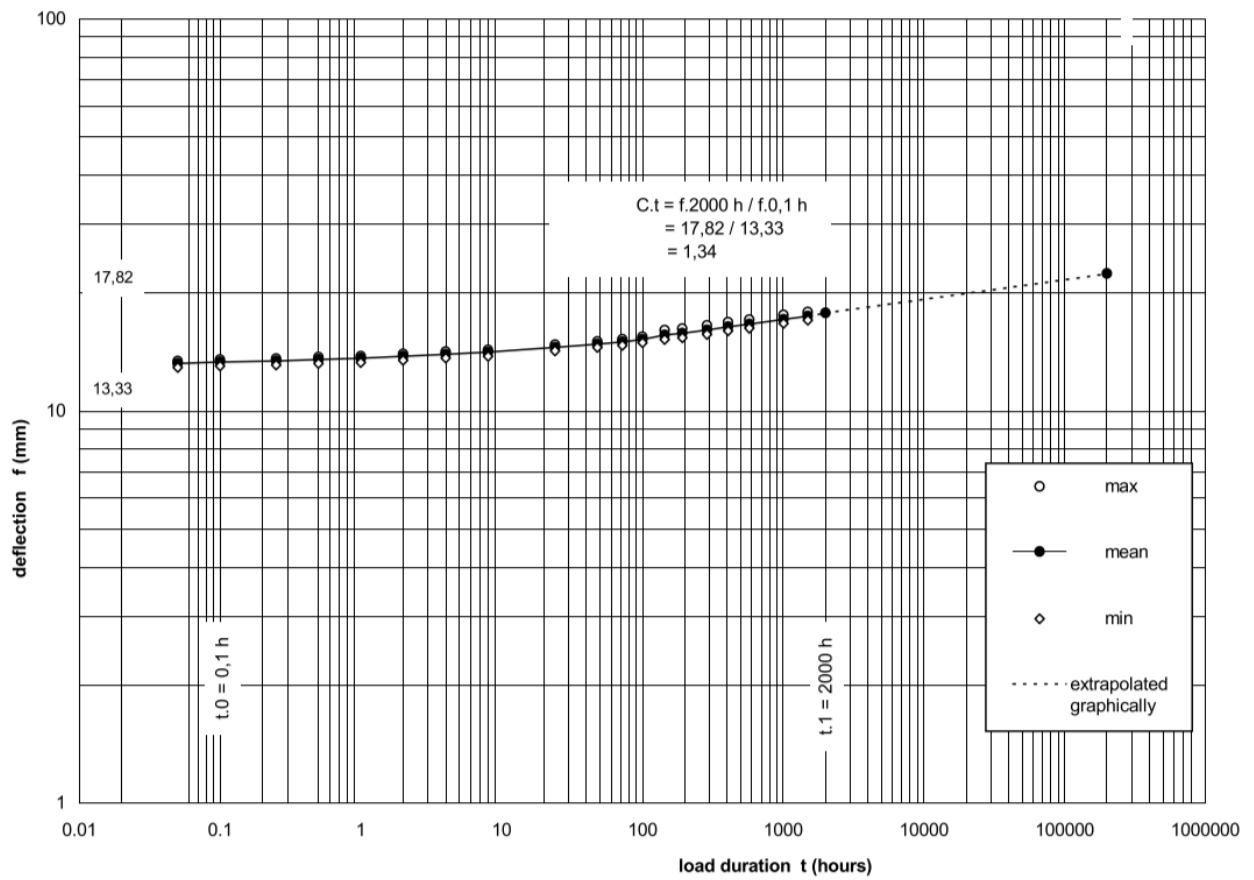
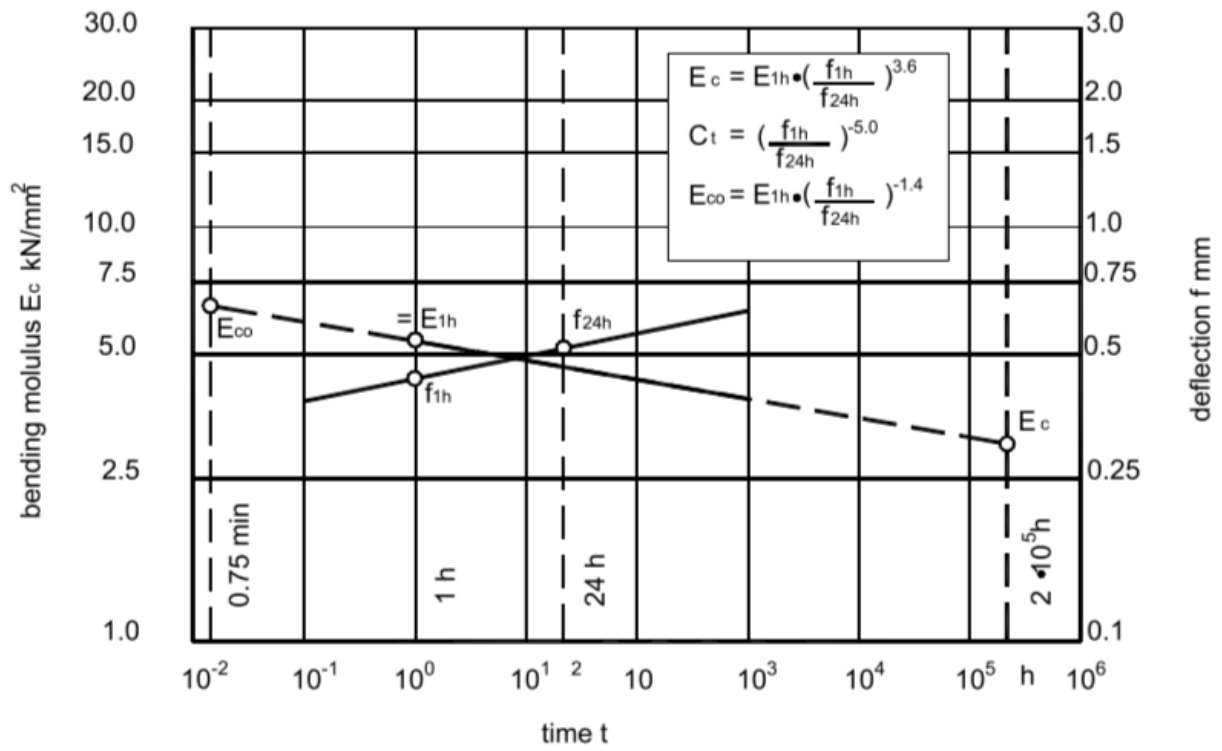


Fig. C.1.6: Time-deflection-curves for a trapezoidal sheet of PVC tested according EN 1013



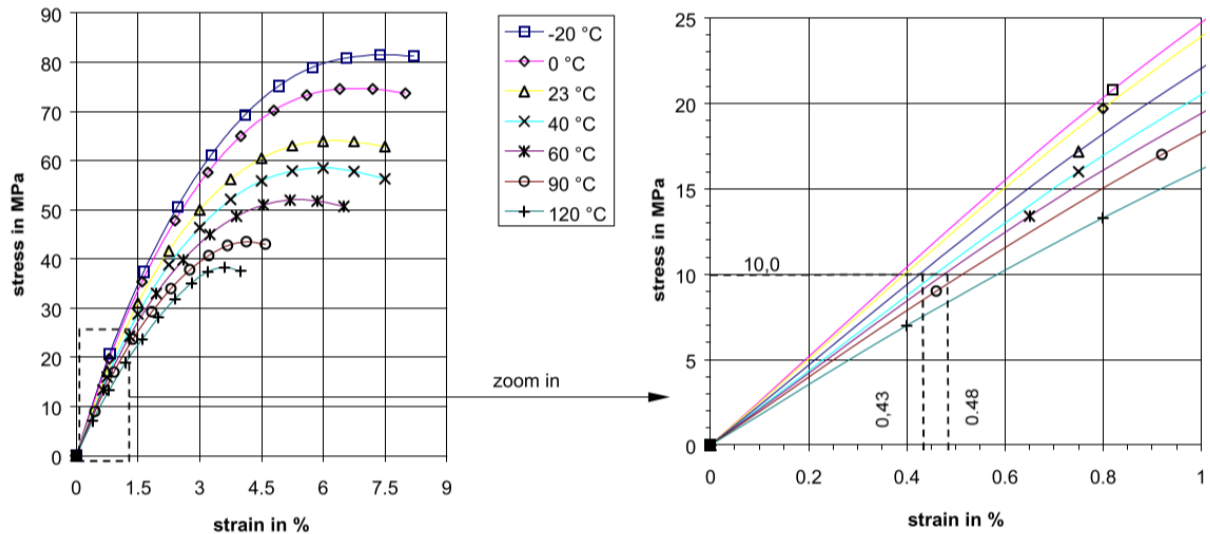
E_{1h} E - modulus, calculated on the basis of the deflection after 1h load duration

f_{1h} deflection after 1h load duration

f_{24h} deflection after 24 hours load duration

C_t magnification factor for a reference time of 2×10^5 h

Fig. C.1.7: Bending modulus behaviour of a sheet of GRP tested according EN ISO 899-2



$$C_{\theta} = \epsilon_{60^{\circ}} / \epsilon_{23^{\circ}} = 0,48 / 0,43 = 1,11$$

Fig. C.2.1: Stress-strain diagram for different temperatures for sheets of PC tested according EN ISO 527 (tension tests)

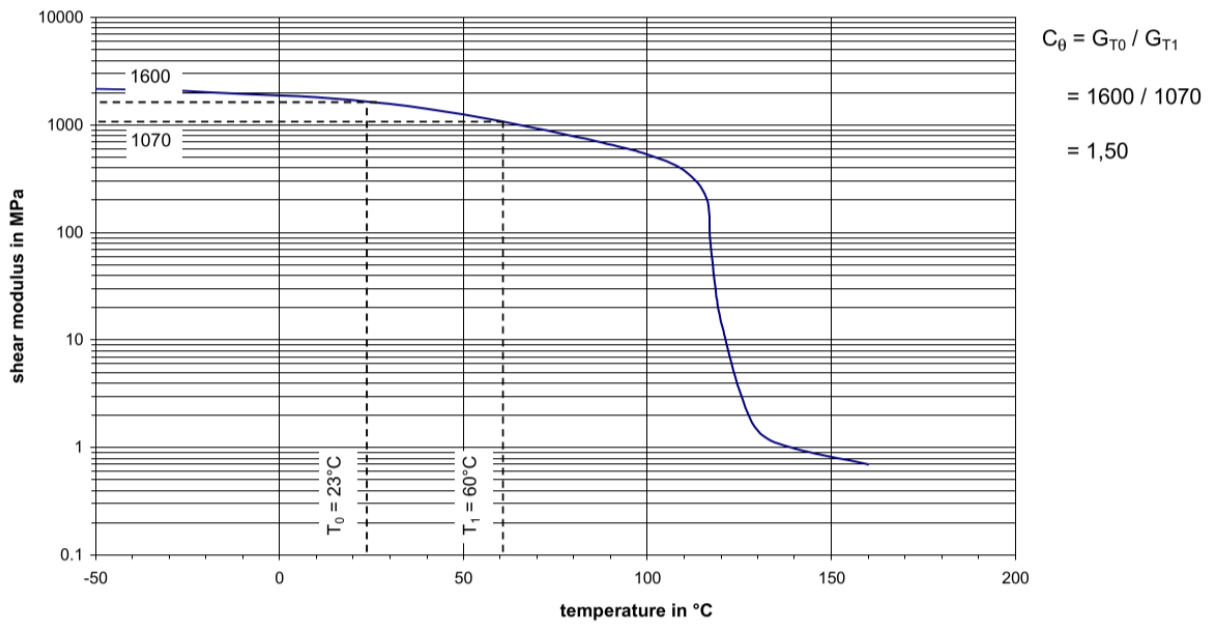


Fig. C.2.2: Shear modulus as a function of temperature for sheets of PMMA tested according EN ISO 6721