European Organisation for Technical Approvals
Europäische Organisation für Technische Zulassungen
Organisation Européenne pour l'Agrément Technique

ETAG 010

Edition September 2002

GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL FOR

SELF SUPPORTING TRANSLUCENT ROOF KITS

EOTA
KUNSTLAAN 40, AVENUE DES ARTS,
1040 BRUSSELS

Table of Contents

FOREWORD

Background

This Guideline has been drawn up by the EOTA Working Group 04.01/09 - *Self Supporting Translucent Roof kits*

The WG consisted of members from Austria, Denmark, France, Germany, Portugal and the United Kingdom with industrial representation from Eurolux.

The Scope of the Guideline is the result of a distinction between EOTA and CEN involvement in the area of roof lights. It was agreed that EOTA would deal with systems as described in the scope of this Guideline, whilst CEN would deal with single-skin corrugated translucent sheets and individual or continuous roof lights, fitted into openings in a conventional roof structure. Furthermore it was recognised that roof lights covered by European standards could be included as components in a roof kit.

The Guideline sets out the performance requirements, the verification methods used to examine the various aspects of performance, the assessment criteria used to judge the performance for the intended use and the presumed conditions for the design and execution of the Self Supporting Roof Kits in the works.

The general assessment approach of the Guideline is based on relevant existing knowledge and testing experience. Assessment criteria were chosen on the basis of an analysis of technical aspects related to the performance of roof kits made of traditional materials.

Where relevant, national technical specifications have been discussed and taken into account in developing appropriate test and calculation methods for assessing the roof kits.

LIST OF REFERENCE DOCUMENTS

Reference documents are referred to within the body of the ETAG and are subject to the specific conditions mentioned therein.
The list of reference documents (mentioning the year of issue) for this ETAG is given in annex H.
When additional parts for this ETAG are written afterwards, they may comprise modifications to the list of reference documents applicable to that part.

Updating conditions

The edition of a reference document given in this list is that which has been adopted by EOTA for its specific use.
When a new edition becomes available, this supersedes the edition mentioned in the list only when EOTA has verified or re-established (possibly with appropriate linkage) its compatibility with the guideline.
EOTA Technical Reports go into detail in some aspects and as such are not part of the ETAG but express the common understanding of existing knowledge and experience of the EOTA-bodies at that moment. When knowledge and experience is developing, especially through approval work, these reports can be amended and supplemented.
EOTA Comprehension Documents permanently take on board all useful information on the general understanding of this ETAG as developed, when delivering ETA's in consensus, by the EOTA members. Readers and users of this ETAG are advised to check the current status of these documents with an EOTA member.
EOTA may need to make alterations/corrections to the ETAG during its life. These changes will be incorporated into the official version on the EOTA website www.eota.be and the actions catalogued and dated in the associated **History File**.
Readers and users of this ETAG are advised to check the current status of the content of this document with that on the EOTA website. The front cover will indicate if and when amendment has taken place.
.

SECTION ONE: INTRODUCTION

1. PRELIMINARIES

1.1 LEGAL BASIS

This ETAG has been established in compliance with the provisions of the Council Directive 89/106/EEC (CPD) and has been established taking into account the following steps:

-the final mandate issued by the EC	: 16/04/98
-the final mandate issued by the EFTA	: 16/04/98
-adoption of the Guideline by the executive Commission of EOTA	: 21/02/01
-opinion of the Standing Committee for Construction	: 22-23/05/01
-endorsement by the EC	: 24/09/02

This document is published by the Member States in the official language or languages according to Art. 11.3 of the CPD.

No existing ETAG is superseded.

1.2 STATUS OF ETAG'S

(a) **An ETA is one of two types of technical specifications** in the sense of the EC Construction Products Directive (89/106/EEC). This means that Member States shall presume the approved products fit for their intended use, i.e. they enable works in which they are employed to satisfy the Essential Requirements during an economically reasonable working life, provided that:

– the works are properly designed and built

– the conformity of the products with the ETA has been properly attested.

(b) This ETAG is a basis for ETA's, i.e. a basis for technical assessment of the fitness for an intended use of a Translucent Roof Kit. An ETA-Guideline is not in itself a technical specification in the sense of the CPD.

This ETAG expresses the common understanding of the approval bodies, acting together within EOTA, of the provisions of the EC Construction Products Directive 89/106 and of the Interpretative Documents in relation to the products and uses concerned, and is written within the framework of a mandate given by the Commission and the EFTA secretariat, after consulting the EC-Standing Committee for Construction.

(c) When accepted by the EC-Commission after consultation with the Standing Committee for Construction and published by the Member States in their official language or languages, this **ETAG is binding** for the issuing of ETA's for the roof kits for the defined intended uses

The application and satisfaction of the provisions of an ETAG (examinations, tests and evaluation methods) leads to an ETA and a presumption of fitness of a Roof kit for the defined use only through an evaluation and approval process and decision, followed by the corresponding attestation of conformity. This distinguishes an ETAG from a harmonised European standard that is the direct basis for attestation of conformity.

Where appropriate, roof kits, which are outside of the precise scope of this ETAG, may be considered through the approval procedure without guidelines according to art. 9.2 of the CPD.

The requirements in this ETAG are set out in terms of objectives and of relevant actions to be taken into account. It specifies values and characteristics, the conformity with which gives the presumption that the requirements set out are satisfied, wherever the state of the art permits and after having been confirmed as appropriate for the particular product by the ETA.

2. SCOPE

2.1 SCOPE

Roof kits comprising the complete* roof covering placed on the market as a kit. The covering itself will be mainly composed of single or multi-layer polymeric translucent elements. They may however include opaque elements.

The roof can be fully self-supporting by virtue of its geometry or can require additional bearing profiles, and may be shaped in such a way that parts of it are vertical. If additional bearing profiles are necessary for full or partial support, these will be supplied as part of the kit or those characteristics affecting the performance of the roof covering will be specified by the ETA holder.

The kits are to be designed and erected in accordance with the ETA-holders specifications and comprise factory produced components as the parts of the kit supplied by the ETA-holder or by other manufacturers supplying to the specification of the ETA-holder who has overall responsibility for the kit.

Outside the scope of this Guideline are:

- Sliding, folding or otherwise opening roof kits, other than may be required for ventilation or maintenance.
- Roof kits that are intended to provide temporary protection to a building
- Roof kits that may be subject to imposed loads other than those detailed in this Guideline, for example pedestrian or other traffic
- Kits incorporating foil or fabric.
- Kits incorporating tensioned cables or other non-rigid structural components.
- Mechanical heat and/or smoke extraction systems.
- Individual and continuous rooflights covered by CEN.

* 'complete' in the sense of the kit including all the required components but not necessarily forming the entire roof of the building

2.2 USE CATEGORIES, PRODUCT FAMILIES, KITS AND SYSTEMS

A Self-Supporting Translucent Roof Kit is intended to provide weather protection and daylight illuminance to any enclosed or partially enclosed building or space.

A Self-Supporting Translucent Roof Kit may or may not:

- incorporate provision for services, maintenance access (e.g. walkways, handrails, and footholds) and safety (e.g. hooks and anchorages), rainwater drainage and ventilation of the building of which it forms the roof or part of the roof

- include openings that allow for ventilation of the building either permanent or under the control of occupier. If the components to be installed in the openings form part of the system, this shall be apparent from the ETA. Unless otherwise stated in the ETA for the roof kit, the components to be installed to provide ventilation and any associated fittings or mechanisms shall be assessed on the basis of the requirements relevant for the components in question and their intended use.

2.3 ASSUMPTIONS

The state of the art does not enable the development, within a reasonable time, of full and detailed verification methods and corresponding technical criteria/guidance for acceptance for some particular aspects or products. This ETAG contains assumptions taking account of the state of the art and makes provisions for appropriate, additional **case by case approaches** when examining ETA-applications, within the general framework of the ETAG and under the CPD consensus procedure between EOTA members.

The guidance remains valid for other cases that do not deviate significantly. The general approach of the ETAG remains valid but the provisions then need to be used case by case in an appropriate way. This use of the ETAG is the responsibility of the ETA-body, which receives the special application, and subject to consensus within EOTA. Experience in this respect is collected, after endorsement in EOTA-TB, in the ETAG Progress File or Comprehension Document.

The Guideline deals with Self Supporting Roof Kits intended for use under the following boundary conditions, which are implicitly assumed throughout the rest of the document:

- As part of structures capable of giving adequate support to the roof and possessing adequate possibilities for attaching the roof to the structure such that all loads can be properly transmitted to the load bearing structure of the building.

- An average ambient air temperature in the range from -30°C to 45°C.

- Hard and soft body impacts as enumerated in this guide.

- Accessibility limited to that required for maintenance and repair only

- As the roof of buildings where requirements with respect to hygiene, air quality, protection against lightning, condensation etc are of the same nature and magnitude as in dwellings, offices, schools, shops, institutions, and places of assembly etc.

The following use conditions are outside the scope:

- Exceptionally severe use such as acts of vandalism.

3. TERMINOLOGY

3.1 COMMON TERMINOLOGY AND ABBREVIATIONS

See Annex A.

3.2 SPECIFIC TERMINOLOGY AND ABBREVIATIONS RELATED TO THE PRODUCTS AND THEIR INTENDED USE COVERED BY THIS GUIDELINE

3.2.1 Self Supporting Roof

A structure enclosing a space, providing it with protection from the weather, and capable of transmitting all permanent and variable actions to the surrounding structure without the use of intermediate elements such as columns, struts, cables etc.

3.2.2 Translucent (roof) unit

A roof or a unit from which a roof is assembled which is capable of transmitting a significant fraction of incident light.

3.2.3 Repeatable unit

A translucent unit, able to be joined to a number of similar such units, whose geometry may vary but otherwise share a common design.

3.2.4 Joint

The connection between adjacent components and/or roof units or between the roof and the surrounding structure.

3.2.5 Support

A load bearing structure, which may be part of the roof but not forming part of the kit.

3.2.6 Additional bearing profile

A load bearing / load transferring member, forming part of the kit. This includes members used to enhance the inherent stiffness of translucent units.

3.2.7 Impost

The point on a structure, at which an arch originates or is supported.

3.3 SYMBOLS

Mechanical resistance and stability

$\{EI\}$	Bending stiffness
$\{GA_Q\}$	Shear stiffness
F	Test load
L	Span
f	Deflection
E_c	Creep modulus
E_{1h}	E modulus calculated from the deflection after 1 h load duration
f_{1h}	Deflection after 1 h load duration
f_{24h}	Deflection after 24 h load duration
f_c	Creep deflection
R_d	Resistance for design purposes - ultimate loadbearing capacity
C_d	Resistance for design purposes – serviceability
η_{dC}	Material factor depending on the magnification factors for the design situation (for failure caused by deformation)
η_{dK}	Material factor depending on the reduction factors for the design situation (for failure caused by breaking)
R_k	Characteristic value of resistance, for the ultimate limit of load bearing.
C_k	Characteristic value of resistance, for the limit of serviceability.

γ_{MR}, γ_{MC}	Partial safety factors for the material/structure in accordance with the uncertainty of the model used.
α_R	Weight factor
β	Reliability index
k	Fractile factor
v	variation coefficient
C_t, C_u, C_θ	Material-dependent magnification factors (duration of loading, ageing/environmental effects and temperature respectively)
K_t, K_u, K_θ	Reduction factors for breaking strength (duration of loading, ageing/environmental effects and temperature respectively)
φ_t	Creep factor
σ	Tensile load
ε	Strain

Protection against noise

R_W	Airborne sound index in dB

Energy economy and heat retention

(W)	S*olar load*- The total thermal energy, absorbed in a buildings interior surfaces, due to optical solar transmission through glazing
τ	Transmission coefficient, transmittance
ρ	Reflectance
θ	Angle of incidence
μ	Refractive index
I	Beam intensity (Wm^{-2})
E	Extinction coefficient
R (value)	Thermal resistance (m^2KW^{-1})
U (value)	Thermal transmittance (Wm^2K^{-1})

Aspects of durability, serviceability and identification

YI	Yellowness index of the aged test piece
YI_0	Yellowness index of the un-aged test piece
ΔYI	Change in yellowness index
X_{CIE}, Y_{CIE}, Z_{CIE}	Colourimetric co-ordinates

SECTION TWO: GUIDANCE FOR THE ASSESSMENT OF THE FITNESS FOR USE

INTRODUCTORY NOTES

(a) Applicability of the ETAG

This ETAG provides guidance on the assessment of a family of self-supporting Translucent Roof Kits and their intended uses. It is the manufacturer or producer who defines the kit for which he is seeking ETA and how it is to be used in the works, and consequently the scale of the assessment.

It is therefore possible that for some kits, which are fairly conventional, only some of the tests and corresponding criteria are sufficient to establish fitness for use. In other cases, eg special or innovative kits or materials, or where there is a range of uses, the whole package of tests and assessment may be applicable.

(b) General lay out of section two

The assessment of the fitness of products with regard to their fitness for intended use in construction works is a process with three main steps:

– Chapter 4 clarifies **the specific requirements for the works** relevant to the products and uses concerned, beginning with the Essential Requirements for works (CPD Art 11.2) and then listing the corresponding relevant characteristics for roof kits.

– Chapter 5 extends the list in Chapter 4 into more precise definitions and the **methods available to verify** product characteristics and to indicate how the requirements and the relevant product characteristics are described. This is done by test procedures, methods of calculation and of proof, etc.

– Chapter 6 provides guidance on **the assessing and judging methods to confirm fitness for the intended use** of the roof kits.

– Chapter 7 **assumptions and recommendations** are only relevant in as far as they concern the basis upon which the assessment of the roof kit is made concerning their fitness for the intended use.

(c) Levels or classes or minimum requirements, related to the Essential Requirements and to the product performance (see ID Clause 1.2)

According to the CPD “Classes” in this ETAG refer only to mandatory levels or classes laid down in the EC-mandate.

This ETAG indicates however the compulsory way of expressing relevant performance characteristics for the roof kit. If, for some uses at least one Member state has no regulations, a manufacturer always has the right to opt out of one or more of them, in which case the ETA will state “no performance determined” against that aspect, except for those properties for which, when no determination has been made the roof kit no longer falls under the scope of the ETAG; such cases shall be indicated in the ETAG.

(d) Working life (durability) and serviceability

The provisions, test and assessment methods in this guideline, or referred to, have been written based upon the assumed intended working life of the assembled roof for the intended use of at least 10 years*, provided that the roof is subject to appropriate use and maintenance (c*f* ch. 7). These provisions are based upon the current state of art and the available knowledge and experience.
An “assumed intended working life” means that it is expected that, when an assessment following the ETAG-provisions is made, and when this working life has elapsed, the real working life may be, in

normal use conditions, considerably longer without major degradation affecting the Essential Requirements.

The indications given as to the working life of a roof kit cannot be interpreted as a guarantee given by the producer or the approval body. They should only be regarded as a means for the specifiers to choose the appropriate criteria for roofs in relation to the expected, economically reasonable working life of the works (based upon ID. Par. 5.2.2).

**Note:* The working life of the assembled system is governed by the working life of the translucent components. Other parts of the kit may have a considerably longer working life e.g. 25 years.

(e) Fitness for the intended use

According to the CPD it has to be understood that within the terms of this ETAG, products shall "have such characteristics that the works in which they are to be incorporated, assembled, applied or installed, can, if properly designed and built, satisfy the Essential Requirements" (CPD, Art 2.1).

Hence, the roof kits must be suitable for use in construction works that (as a whole and in their separate parts) are fit for their intended use, account being taken of economy, and in order to satisfy the Essential Requirements. Such requirements must, subject to normal maintenance, be satisfied for an economically reasonable working life. The requirements generally concern actions that are foreseeable.(CPD Annex I, preamble).

4. REQUIREMENTS FOR WORKS AND THEIR RELATIONSHIP TO THE PRODUCT CHARACTERISTICS

This chapter sets out the aspects of performance to be examined in order to satisfy the relevant Essential Requirements, by:

– expressing in more detail, within the scope of the ETAG, the relevant Essential Requirements of the CPD in the Interpretative Documents and in the mandate, for works or parts of the works, taking into account the actions to be considered, as well as the expected durability and serviceability of the works.

– applying them to the scope of the ETAG (Roof kit and where appropriate its constituents, components and intended uses), and providing a list of relevant product characteristics and other applicable properties.

When a product characteristic or other applicable property is specific to one of the Essential Requirements, it is dealt with in the appropriate place. If, however, the characteristic is relevant to more than one Essential Requirement, it is addressed under the most important one with cross-reference to the other(s). This is especially important where a manufacturer claims “No performance determined” for a characteristic or property under one Essential Requirement and it is critical for assessing and judging under another. Similarly, characteristics or properties that have a bearing on durability assessments, may be dealt with under ER1 to ER6, with reference under 4.7. Where there is a characteristic which only relates to durability, this is dealt with in 4.7.

This chapter also takes into account further requirements, if any (e.g. resulting from other EC Directives) and identifies aspects of serviceability including specifying characteristics needed to identify the products (c*f*. ETA-format par. II.2).

The relevant Essential Requirements, the relevant paragraphs of the corresponding IDs and the related requirements to product performance are indicated in the following table 4.1:

Table 4.1:

ER	Corresponding ID Paragraph for works	Corresponding ID paragraph for product performance	Product Characteristics from the Mandate	ETAG paragraph on product performance	Related durability aspects
1	3.4 Methods for verifying mechanical resistance and stability for works	4.3 Provisions concerning products	Mechanical resistance (resistance to wind, snow, permanent thermal and live loads) Racking resistance	4.1.1 Collapse and major deformations 4.1.2 Racking resistance 4.1.3 Actions	Resistance to deterioration caused by – physical agents – biological agents – chemical agents related to performance under ER 1-6
2	4.2 Provisions concerning works or parts of them 4.2.4 Limitation of spread of fire to neighbouring construction 4.2.3.3 Limitation of the generation and spread of fire and smoke within the room of origin 4.2.3.4 Limitation of fire and smoke beyond the room of origin	4.3.1.2.2 Roofs exposed to an external fire 4.3.1.1 Products subject to reaction to fire requirements 4.3.1.2.1 Roofs exposed to an internal fire 4.3.1.3 Products subject to resistance to fire requirements	External fire performance Reaction to fire Resistance to fire	4.2.1 External fire performance 4.2.2 Reaction to fire 4.2.3 Resistance to fire	
3	3.3.1.1 Air quality 3.3.1.2 Dampness	3.3.1.1.3.2.a Building materials (Cat B) 3.3.1.1.3.2.d.2 Barriers and sealants Dampness on indoor surfaces – moisture proofing avoiding condensation	Release of dangerous substances Watertightness (Resistance to penetration by rain or snow)	4.3.1 Release of dangerous substances 4.3.2 Watertightness and presence of dampness	
4	3.3.2 Direct impacts 3.3.2.2 Performance of the works – behaviour on impacts (eg strength, ability to prevent penetration of falling people or objects, shatter properties, size of shatter fragments, etc) 3.3.1 Falling (handrails only) 3.3.1.2 Performance of the works – A minimum capability to resist horizontal thrust is required	3.3.2.3 Essential characteristics of the products – mechanical resistance and stability 3.3.1.3 Essential characteristics of the product – capability to resist horizontal thrust	Impact resistance Shatter properties/safe breakability Resistance to live horizontal loads Definition of geometry Safe opening (eg windows)	4.4.1 Mechanical resistance and stability 4.4.1.1 Impact resistance 4.4.1.2 Shatter properties/safe breakability 4.4.1.3 Resistance to live horizontal loads 4.4.1.4 Definition of geometry 4.4.1.5 Safe opening	
5	4.2 Provisions concerning works or parts of them 4.2.1 Calculation methods 4.2.2 Laboratory methods – Direct airborne sound reduction of an element of known surface area 4.2.4 Verification methods based on in-situ tests	4.3 Provisions concerning products 4.3.2.1 Acoustic properties of building products – Direct airborne sound reduction	Direct airborne sound insulation	4.5.1 Airborne sound insulation	

6	4.2 Provisions concerning works or parts of them 4.2.3 Expression of energy requirements and their relation to product characteristics	4.3. Provisions concerning products 4.3.2.2 Fabric components	Thermal performance Air permeability Radiation properties – solar transmission	4.6.1 Thermal resistance 4.6.2 Moisture transfer 4.6.3 Air permeability 4.6.4 Solar transmission	

4.1 MECHANICAL RESISTANCE AND STABILITY

The Essential Requirement laid down in the Council Directive 89/106/EEC is as follows:
The Construction Works must be designed and built in such a way that the loads that are liable to act on during its construction and use will not lead to any of the following:

– collapse of the whole or part of the works

– major deformations to an inadmissible degree

– damage to other parts of the works or to fittings or installed equipment as a result of major deformation of the load bearing construction

– damage by an event to an extent disproportionate to the original cause

This means that the roof shall have sufficient mechanical resistance and stability to withstand static or dynamic loads from the actions outlined below, without exceeding its ultimate or serviceability limit states.

4.1.1 Collapse and Major Deformations

The ultimate and serviceability limit states for demonstrating compliance with the Essential Requirement, Mechanical resistance and stability, shall be in accordance with laws, regulations and administrative provisions, applicable for the location where the roof is incorporated in the works.

When considering its performance in relation to this requirement the approval body shall have regard to the actions upon the roof given in 4.1.3.

4.1.2 Racking resistance (of the roof)

In-plane rotation, otherwise known as the 'racking resistance', at any joints or junctions in the roof, whether accompanied by deformation or not, shall be such that, in the limit states, the overall stability of the roof is not impaired,

4.1.3 Actions

The range of values for actions and other influences that need to be considered shall be in accordance with laws, regulations and administrative provisions, applicable for the location where the product is incorporated in the works.

4.1.3.1 Permanent actions

Actions arising from the self-weight of the structure, including also any additional dead loads arising during construction and maintenance.

4.1.3.2 Variable actions

These are the loads imposed during the life of the roof arising from the action of the wind, snow, ice, thermal expansion, frost and those temporary loads arising where access is permitted.

4.1.3.3 Accidental actions

Temporary loads arising from specific combinations of variable actions.

4.2 SAFETY IN CASE OF FIRE

The Essential Requirement laid down in the Council Directive 89/106/EEC is as follows:

The construction works must be designed and built in such a way that in the event of an outbreak of fire:

— the load bearing capacity of the construction can be assumed for a specific period of time

— the generation and spread of fire and smoke within the works are limited

— the spread of fire to neighbouring construction works is limited

— occupants can leave the works or be rescued by other means

— the safety of rescue teams is taken into consideration

The following aspects of performance are relevant to this Essential Requirement for Self-Supporting Roof Kits:

4.2.1 External fire performance

Requirements for the external fire performance of the assembled roof shall be in accordance with laws, regulations and administrative provisions, applicable for the location where the product is incorporated in the works and shall be specified in accordance with the relevant EC decision and the CEN classification documents.

4.2.2 Reaction to fire

Requirements for the reaction to fire of the product/kit shall be in accordance with laws, regulations and administrative provisions, applicable for the location where the product is incorporated in the works and shall be specified in accordance with the relevant EC decision and the CEN classification documents.

4.2.3 Resistance to fire

Requirements for the reaction to fire of the product/kit shall be in accordance with laws, regulations and administrative provisions, applicable for the location where the product is incorporated in the works and shall be specified in accordance with the relevant EC decision and the CEN classification documents.

4.3 HYGIENE, HEALTH AND THE ENVIRONMENT

The Essential Requirement laid down in the Council Directive 89/106/EEC is as follows:

The construction works must be designed and built in such a way that it will not be a threat to the hygiene or health of the occupants or neighbours, in particular as a result of any of the following:

– the giving-off of toxic gases

– the presence of dangerous particles or gases in the air

– the emission of dangerous radiation

– pollution or poisoning of the water or soil

– faulty elimination of waste water, smoke, solid or liquid wastes

– the presence of damp in parts of the works or on surfaces within the works.

The following aspects of performance are relevant to this Essential Requirement for Self-Supporting Roof Kits.

4.3.1 Release of dangerous substances

The product/kit must be such that, when installed according to the appropriate provisions of the Member States, it allows for the satisfaction of the ER3 of the CPD, as expressed by the national provisions of the Member States and, in particular, does not cause harmful emission of toxic gases, dangerous particles or radiation to the indoor environment nor contamination of the outdoor environment (air, soil or water).

4.3.2 Watertightness and presence of dampness

The design of the roof kit shall be such that when the product is in service there will be no threat to the health of the occupants or neighbours as a result of:

– ingress of rainwater or snow

– presence of moisture condensation, which could promote the growth of fungi or other micro organisms, or could flow into or otherwise enter the building (relevant also to consideration under ER6)

4.4 SAFETY IN USE

The Essential Requirement laid down in the COUNCIL DIRECTIVE 89/106/EEC is as follows:

The construction works must be designed and built in such a way that it does not present unacceptable risks of accidents in service or in operation such as slipping, falling, collision, burns, electrocution, injury from explosion.

The following aspects of performance are relevant to this Essential Requirement for Self-Supporting Translucent Roof Kits:

4.4.1 Mechanical resistance and stability (c*f*. Essential Requirement 4.1)

The assembled roof shall have sufficient mechanical resistance and stability under all loading conditions or combinations, foreseeable for the application, to ensure that the safety of the occupants of buildings, of which it forms the roof, is not endangered.

4.4.1.1 Impact resistance

The risk and effect of direct impact shall be considered in relation to collisions of persons with parts of the roof, for example opening parts, and/or the possibility of persons falling through brittle elements.

4.4.1.2 Shatter properties/ Safe breakability

This aspect of performance has relevance when considering the effect of direct impact under 4.4.1.1. In addition, shatter properties/safe breakability shall be considered in relation to the risk to building users following impact/breakage of any part of the assembled roof by any of the following actions:

- Self weight of the roof structure and transmitted bending and shear forces from adjacent elements
- Wind pressures both positive and negative from within and external to the building
- Weight of deposited snow and ice
- Loads arising during construction and maintenance, e.g. Movement of tools
- Impacts resulting from hail
- Impacts resulting from a person falling against the roof
- Differential thermal expansion arising from solar heating and internal/external temperature differences
- Vibration or explosion in the building dislodging or fracturing the roof or parts of the roof

4.4.1.3 Resistance to live horizontal loads

Where access walkways are provided as part of a roof kit, or where the roof kit can be used to cover such a walkway, handrails forming part of these walkways shall exhibit sufficient resistance to live horizontal loads to minimise the risk of falling from the roof or falling against brittle elements.

4.4.1.4 Definition of geometry

The geometry of those parts of an assembled roof, which might present a risk of tripping or falling, shall be such that these risks are minimised.

4.4.1.5 Safe opening

Any roof kit, which incorporates opening elements, shall be designed or shall incorporate measures to ensure that the risk of collision or falling through these elements is minimised.

4.5 PROTECTION AGAINST NOISE

The Essential Requirement laid down in the Council Directive 89/106/EEC is as follows:

The construction works must be designed and built in such a way that noise perceived by the occupants or people nearby is kept down to a level that will not threaten their health and will allow them to sleep, rest and work in satisfactory conditions.

4.5.1 Airborne Sound Insulation

Where required by the laws, regulations and administrative procedures for the location concerned this Essential Requirement is relevant to roof kits within the scope of this Guideline in relation to protection against airborne noise from outside the works or from another enclosed space.

4.6 ENERGY ECONOMY AND HEAT RETENTION

The Essential Requirement laid down in the Council Directive 89/106/EEC is as follows:

The construction works and its heating and ventilation installations must be designed and built in such a way that the amount of energy required in use shall be low, having regard to the climatic conditions of the location and the requirements of the occupants.

When used as the roof for an enclosed habitable space the roof kit shall have adequate thermal insulating properties in order to

– limit energy consumption

– limit discomfort caused by radiation or convection (draught)

– limit water vapour condensation within the roof or on any of its surfaces.

4.6.1 Thermal performance

The thermal transmittance/resistance of the roof kit shall be used to establish that it is in accordance with laws, regulations and administrative provisions, applicable for the location where the product is incorporated in the works.

If there is any discontinuity in the assembled system, such as a bearing profile, then the effect of thermal bridging shall be considered.

4.6.2 Moisture transfer

The roof kit shall be designed, constructed and installed in such a way that moisture transfer through the assembled roof does not cause excessive water vapour condensation within the roof elements or on glazing or its internal surfaces.

4.6.3 Air permeability

The rate of air infiltration through the assembled roof shall be considered with particular reference to joints, penetrations and glazing.

4.6.4 Radiation properties – solar transmission

The transmission of solar energy through the roof shall be established where energy consumption for cooling needs determination. This data may also be used to assess the contribution of the roof to the buildings daytime illuminance.

4.7 ASPECTS OF DURABILITY, SERVICEABILITY AND IDENTIFICATION

4.7.1 Resistance to corrosion and deterioration

The requirements considered in the following paragraphs are related to the Essential Requirements, but not to any one requirement in particular. As a consequence, failure to meet these requirements means that more than one of the Essential Requirements may no longer be met.

Roof assemblies and components and their various finishes shall be protected against/ resistant to deterioration caused by physical, chemical or biological agents in order to prevent reduction of mechanical or other properties.

4.7.1.1 Resistance to various agents

The roof kit, including its bearing profiles and joints, shall not be adversely affected by deterioration, distortion, and deformation due to:

Physical agents

– Variations in temperature/humidity

– Differential temperature and/or relative humidity

- Ultra-violet radiation arising from solar irradiation
- Ageing effects, due to temperature cycling and thermal shock

Chemical agents

- Water, carbon dioxide, oxygen (possible corrosion) and other normal chemical hazards likely to come into contact, for example cleaning materials.
- Corrosion from weather and industrial, urban or marine environments or a combination of these.

Biological agents

- Fungi, bacteria, alga and insects.
- The roof kit shall be designed and built in such a way that it does not encourage infestation by insects or vermin.

5. METHODS OF VERIFICATION

This Chapter refers to the verification methods used to determine the various aspects of performance of the products in relation to the requirements for the works (calculations, tests, engineering knowledge, site experience, etc.) as set out in chapter 4.

Not all the Essential Requirements will be relevant to every kit. A 'no performance determined' option is possible in some cases and it will be for the manufacturer to decide, taking account of his intended market, which options he wishes to have assessed.

Unless otherwise stated in the test methods, loads and forces shall be accurate to within ±2%, dimensions to within ±1%, temperature to within ±5% and relative air humidity to within ±5% of the stated values.

This Guideline assumes (see 2.3 Assumptions) that Roof Kits are for use generally in an ambient air temperature ranging from -30ºC to 45ºC. However, where a particular kit is intended for use predominantly at the lower end of this range this must be taken into account and test conditions may need to be varied accordingly.

When EUROCODES are quoted in this ETAG as the methods for the verification of certain product characteristics, their application in this ETAG, as well as in the subsequent ETA's issued according to this ETAG, shall be in accordance with the principles laid down in the EC Guidance Paper L on the use of EUROCODES in harmonised European technical specifications.

The relevant Essential Requirements, the corresponding product characteristics to be assessed and the corresponding verification methods are indicated in the following table 5.1:

Table 5.1: Product characteristics and corresponding verification methods

ER	ETAG paragraph on product performance	ETAG paragraph on verification method of product characteristics	
		KITS/SYSTEM	COMPONENTS
1.	4.1.1 Collapse and major deformations 4.1.2 Racking resistance	5.1.1.1 Mechanical resistance and stability – General 5.1.1.2 Racking resistance	5.2 ADDITIONAL BEARING PROFILES 5.2.1 Mechanical resistance and stability
			5.3 TRANSLUCENT SHEETS 5.3.1.1 General 5.3.1.2 Full-scale tests 5.3.1.3 Small-scale (characterisation) tests
			5.5 FIXINGS 5.5.1 Mechanical resistance and stability
2.	4.2.1 External fire performance 4.2.2 Reaction to fire 4.2.3 Resistance to fire	5.1.2.1 External fire performance 5.1.2.2 Reaction to fire 5.1.2.3 Resistance to fire	5.2 ADDITIONAL BEARING PROFILES 5.2.2.1 Reaction to fire
			5.3 TRANSLUCENT SHEETS 5.3.2.1 Reaction to fire
			5.4 SEALS AND GASKETS 5.4.2.1 Reaction to fire
3.	4.3.1 Release of dangerous substances 4.3.2 Watertightness and presence of dampness	5.1.3.1 Release of dangerous substances 5.1.3.2 Watertightness and presence of dampness	ALL COMPONENTS (5.2.3.1, 5.3.3.1, 5.4.3.1, 5.5.3.1) Release of dangerous substances
4.	4.4.1 Mechanical resistance and stability 4.4.1.1 Impact resistance 4.4.1.2 Shatter properties/safe breakability 4.4.1.3 Resistance to live horizontal loads 4.4.1.4 Definition of geometry 4.4.1.5 Safe opening	5.1.4.1 Impact resistance 5.1.4.2 Shatter properties/safe breakability 5.1.4.3 Resistance to live horizontal loads 5.1.4.4 Definition of geometry 5.1.4.5 Safe opening	TRANSLUCENT SHEETS 5.3.4 Safety in use

ER	ETAG paragraph on product performance	ETAG paragraph on verification method of product characteristics	
		KITS/SYSTEM	COMPONENTS
5.	4.5.1 Airborne sound insulation	5.1.5.1 Sound insulation	Not relevant
6.	4.6.1 Thermal resistance 4.6.2 Moisture transfer 4.6.3 Air permeability 4.6.4 Solar transmission	5.1.6.1 Thermal resistance 5.1.6.2 Condensation 5.1.6.3 Air permeability 5.1.6.4 Solar transmission	ADDITIONAL BEARING PROFILES 5.2.3.2 Condensation 5.2.6 Energy economy and heat retention
			TRANSLUCENT SHEETS 5.3.3.2 Condensation 5.3.6 Energy economy and heat retention
*	4.7.1 Resistance to corrosion and deterioration	5.1.7.1 Resistance to corrosion and deterioration	ADDITIONAL BEARING PROFILES 5.2.7 Aspects of durability and serviceability
			TRANSLUCENT SHEETS 5.3.7.1 Durability 5.3.7.2 Serviceability 5.3.7.3 Identification
			SEALS AND GASKETS 5.4.7 Aspects of durability
			FIXINGS 5.5.7 Aspects of durability

* Aspects of durability, serviceability and identification

5.1 KITS/SYSTEMS

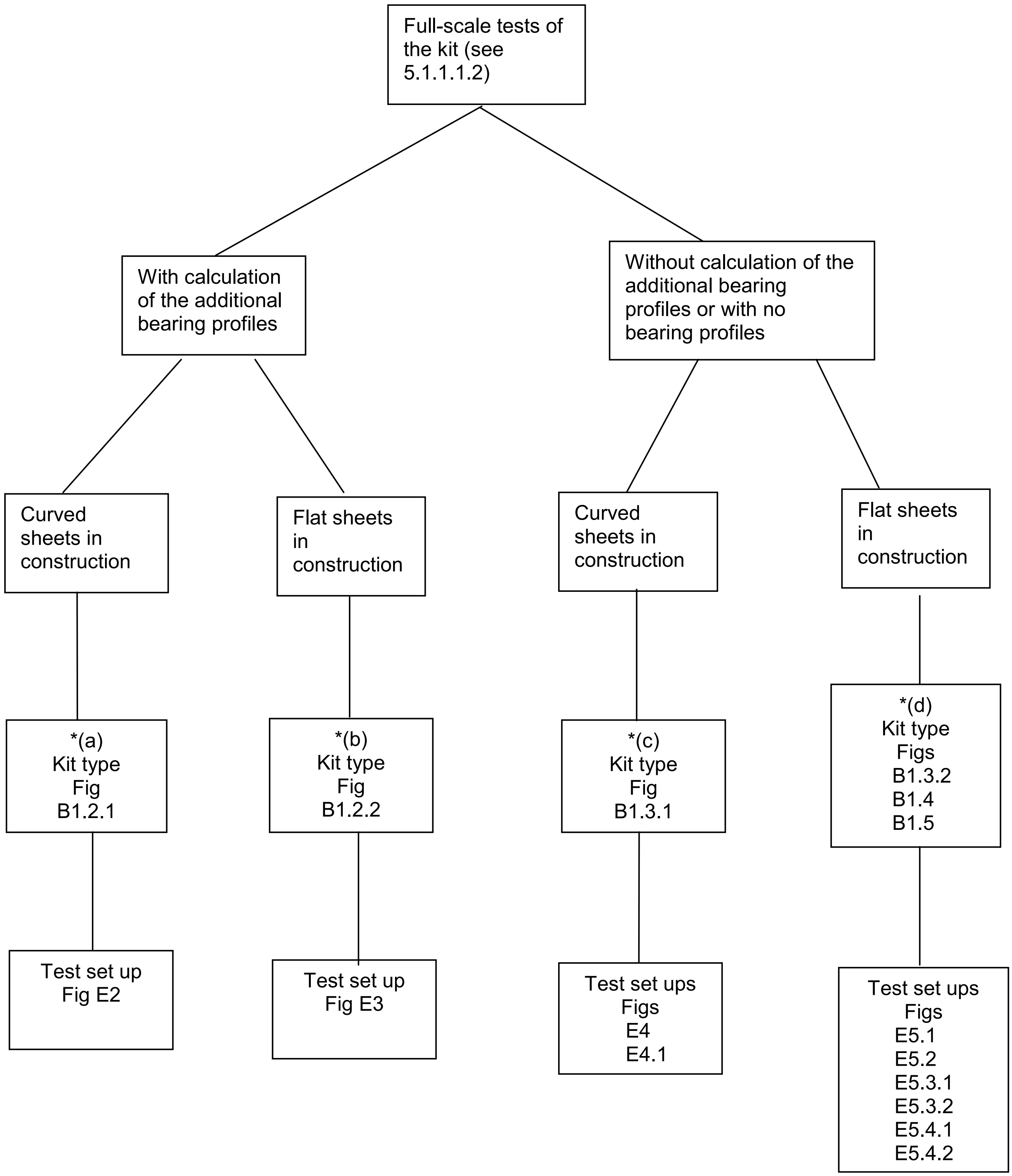
5.1.1 Mechanical resistance and stability

5.1.1.1 General

The determination of mechanical resistance and stability – ultimate load bearing capacity and serviceability - shall to be undertaken on the basis of ENV 1991-1 (Eurocode 1). The verification may be by testing or a combination of calculation assisted by testing. An overview in form of a flowchart is shown in Fig. 1 that relates kit-type to test set-up.

As part of the process of determination of overall capacity of the kit, it may be possible to determine the capacity of the bearing profiles by calculation alone. It is necessary to decide in consultation with the manufacturer/ETA applicant at the commencement of the assessment whether this approach is to be taken, normally in accordance with the relevant structural Eurocodes (see 5.2.1).

An Approval Body may take into consideration results generated by computer software used by the applicant to determine the mechanical resistance of various parts of the kit. However, such software must be validated before use, for example against the results of tests.



*Kit types are described in 5.1.1.1.1 and shown in Annex B.

Test set-ups are described in 5.1.1.2 and shown in Annex E.

Fig 1 Overview of testing for mechanical resistance and stability, showing the relationship between kit-types and test set ups

5.1.1.1.1 Kit types

With regard to the static system, roof kits/systems can be divided into four different categories. Each category can be assembled using repeatable units:

a) Curved roof systems with additional bearing profiles parallel to the span.

These systems consist of a sub-structure with additional bearing profiles parallel to the span, a support structure for the sheet ends transverse to this and a covering of flat solid or structured sheets. As the rigidity of the bearing profiles is very high in relation to the covering, to assess the load-bearing capacity and serviceability, the covering alone can be studied. Here it is assumed that the load-bearing construction of the roof system is stable in itself and the covering is not required to contribute to this, e.g. for protection against overturning.
The covering can be designed as a single span system without intermediate support, or as a multi-span system with further bearing profiles arranged at equidistant intervals. The covering is held against uplift loads by capping profiles which are either bolted or clamped along the bearing profile or, for curved systems, act as tie-backs attached to the impost (fig B1.2.1 Annex B)

b) Flat roof systems with additional bearing profiles parallel to the span

These systems are, in principle, similar to the curved systems above. However, resistance to uplift loads can only be provided by bolted or clamped capping profiles. (fig B1.2.2 Annex B).

c) Curved roof systems with no additional bearing profiles (also curved roof systems where additional bearing profiles are not calculated separately)

Curved roof systems with no additional bearing profiles consist of single or multi-layer elements, which have no further supports transverse to the main load-bearing direction other than at the ends of the elements. The covering can consist of profiled sheets with overlaps or hollow profiled sheets or structured sheets with joints on the long sides (fig B1.3.1 Annex B).

d) Flat roof systems with no additional bearing profiles

These flat roof systems consist either of hollow profiled sheets or structured sheets connected together by means of a joint on the long side or of profiled sheets that can be overlapped at the longitudinal and transverse edges. They can be constructed as single-span systems (fig. B1.3.2 Annex B) or, with additional intermediate supports transverse to the main bearing direction, as multi-span systems (fig. B1.4 or B1.5). The hollow profiles or structured sheets are held by support profiles at the ends and by screws or lift anchors at the intermediate supports (fig B 1.4).
For profiled sheets the fixings can be applied at either the peaks or the troughs. The sheets are mounted with a fixed projection on the end supports (fig B1.5)

5.1.1.1.2 Full-scale tests of the kit

Having decided whether the bearing profiles are to be calculated separately and then following the relevant route through Fig 1, full-scale tests shall be performed to determine the behaviour of the complete system under downward load and uplift load. All types of actions to be expected shall be simulated in at least three tests and the limit states for load-bearing capacity and, where applicable, serviceability analysed statistically in accordance with the principles of the relevant Eurocode.

The testing shall be carried out on sample roof kits, representative of those to be supplied and/or erected in practice. The selection of the sample or samples needs careful consideration to ensure that it is fully representative. Normally, the sample(s) shall be taken from production and be fabricated in strict accordance with the manufacturer's drawings, specification and installation instructions. Whenever possible, the installation of the test sample, into an appropriate test rig, shall be carried out by the manufacturer or ETA applicant.

Where possible, over-size sheets should be provided for the full scale test to allow representative samples to be removed, prior to installation in the test rig, for the purposes of the small-scale tests under 5.3.1.3.

Several groups of specimens may need to be tested to gain information about the full range of options available for a given system, for example, changes to member size throughout the range.

5.1.1.1.2.1 Test method

In testing, the load type to be simulated shall be applied to the roof system or part system as a variable load as close to reality as possible. 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). The test loads shall increase up to failure in even time intervals. The test shall be undertaken in an environment where a temperature of 23 ± 3ºC is maintained.

5.1.1.1.2.2 Test Structure

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

As proof of load-bearing capacity and serviceability against gravity loads from snow or wind and for uplift loads from wind, the following tests are required as a function of the static system.

The static systems for the various roof kit types are described in 5.1.1.1.1 and the reference figures are contained in Annex B. Annex E shows a chart (Fig E.1) that gives an overview of the approach to testing (with particular reference to the sheets). The subsequent information in Annex E gives test details related to the various types of roof kit.

a) Curved roof systems with additional bearing profiles parallel to the main load-bearing direction.

   The test structure for this system is shown schematically in fig E2 for downward and uplift loading. For test purposes, to assess the load-bearing capacity and serviceability, the bearing profiles can be reinforced (propped) e.g. by auxiliary members so that adequate stability is ensured up to the failure load of the sheets.

b) Flat roof systems with additional bearing profiles parallel to the span.

   For flat roof systems the test structure is shown schematically in fig E3. The information given above in a) applies equally to the test structure for this type of kit.

c) Curved roof systems with no additional bearing profiles (also curved roof systems <u>with</u> additional bearing profiles but not calculated separately)

   The test structure to prove the load-bearing capacity and serviceability is shown schematically in fig E4. In addition to the test for downward and uplift loading applied over the full span, in curved systems the half-span gravity load test shall also 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.
   For these systems, if the support anchoring alone is decisive in preventing uplift, the test can be restricted to this part of the system (see Tensile test in fig E4.1).

   For curved roof systems with additional bearing profiles that are not calculated separately, the full-scale tests may be initially carried out with propping of the loadbearing profiles, as described in a) in order to determine the loadbearing capacity and serviceability of the sheets. Subsequently, the tests may be carried out on the system without propping to determine the contribution of the profiles. These latter tests may require replacement of some or all of the sheets.
   If the two-stage approach is not used, eg for reasons of economy, the calculated resistance for the assembly will be more conservative. It will be impossible to separate the contribution of the translucent sheets and the bearing profiles and thus the factors for the sheets (see 6.3.1.1) will also be imposed on the profiles.

d) Flat roof systems without additional 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 behaviour on intermediate supports and an assessment of the acceptable reactions are decisive. The test can be generally in accordance with ENV 1993-1-3 (Eurocode 3).
The test structure to determine the limit state of bending moment with no transverse force (mid-span moment) is shown schematically in figs E5.1 and E5.2. 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.
Auxiliary constructions may be used which restrict the horizontal displacement of the elements transverse to the main load-bearing direction. These must not increase the rigidity in the profile 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 E5.3.1 and E5.3.2 for gravity load application and in figs E5.4.1 and 5.4.2 for uplift loading.
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.
For the end reactions, provided that $l_o \geq 50$ mm, 60% of the determined maximum intermediate reactions can be used. The end reactions can also be proven in additional tests.

5.1.1.2 Racking resistance (of the roof)

In systems with additional bearing profiles, the ability of the profile assembly to provide racking resistance to the roof may be determined during the calculation process for the profiles; in particular the ability of the joints to resist in-plane rotation.

For the roof as a whole to have racking resistance, the roof elements must be connected to one another and/or to the profiles in a manner that will accept significant shear forces; frictional interconnection will not be sufficient.

In practice rigid connections are not normally provided due to the need to accommodate thermal movement. If there is no connection other than friction between elements, only one element can be taken into account for verification of the racking resistance of the roof.
Where calculation of the bearing profiles is not undertaken as a separate exercise, the racking resistance of the roof (if claimed) can be tested in accordance with Annex C.

5.1.2 Safety in case of fire

5.1.2.1 External fire performance

The product shall be tested in order to be classified in accordance with EC Decision 2001/671/ EC and classification standard prEN 13501-5
Products that are included in Commission Decision 2000/553/EC can be considered as deemed to satisfy the external fire performance characteristics without the need for testing.

5.1.2.2 Reaction to fire

The product shall be tested in order to be classified in accordance with EC Decision 2000/147/ EC and classification standard prEN 13501-1

5.1.2.3 Resistance to fire

The product shall be tested in order to be classified in accordance with EC Decision 2000/367/ EC and classification standard prEN 13501-2

Testing of the heat and/or smoke extraction performance of natural ventilation systems, if incorporated in the roof kit is described in prEN 12101 Part 2 and Part 4.

5.1.3 Hygiene, health and the environment

5.1.3.1 Release of dangerous substances

5.1.3.1.1. Presence of dangerous substances in the product

The applicant shall submit a written declaration stating whether or not the kit contains dangerous substances according to European and national regulations, when and where relevant in the Member States of destination, and shall list these substances.

5.1.3.1.2 – Compliance with the applicable regulations

If the kit contains dangerous substances as declared above, the ETA will provide the method(s) which has been used for demonstrating compliance with the applicable regulations in the Member States of destination, according to the dated EU data-base (method(s) of content or release, as appropriate).

5.1.3.1.3 – Application of the precautionary principle

An EOTA member has the possibility to provide to the other members, through the Secretary General, warnings about substances which, according to health authorities of its country, are considered to be dangerous under sound scientific evidence, but are not yet regulated. Complete references about this evidence will be provided.

This information once agreed upon, will be kept in an EOTA database, and will be transferred to the Commission services.

The information contained in this EOTA database will also be communicated to any ETA applicant.
On the basis of this information, a protocol of assessment of the product, regarding this substance, could be established on request of a manufacturer with the participation of the Approval Body that raised the issue.

5.1.3.2 Watertightness and presence of dampness

The basis for assessing this requirement is the roof's resistance to the ingress of rain and snow and the possibilities of condensation under the envisaged conditions of use.

5.1.3.2.1 Resistance to wind driven rain and snow

Water leakage resistance of the roof, including driving rain and possibly snow penetration, shall primarily be assessed by the approval body on the basis of the standard construction details for the kit and by using available technical knowledge and experience from similar well-known technical solutions.
The assessment must include principal joints between the kit and the substructure where these form part of the manufacturer's specification.

Where it is necessary to test the ability of the roof to meet the requirements for resistance to the ingress of wind-driven rain and snow, representative full scale testing will be required. The method described in Annex D shall be used.
Where a roof kit incorporates provisions for permanent ventilation it may be necessary to block ventilators to obtain the air pressures necessary for testing. If this step is taken it must be ensured, by inspection or by undertaking a further test with the ventilators unblocked, that they do not themselves compromise watertightness.

The airtightness, watertightness and wind load resistance of opening elements may be determined in separate tests using the methods for windows, given in EN's 1026, 1027 and 12211.

Gutter systems/components in PVC-U and sheet metal may be assessed by reference to EN 607, EN 1462, prEN 12200 and EN612.

5.1.3.2.2 Condensation

The estimation of condensation risk, which is relevant to this Essential Requirement, will require thermal conductivity or resistance and water vapour resistance or equivalent air layer thickness data for the roof materials and any cold bridges in the roof assembly, even if the thermal performance of the roof is not to be assessed.

The methods are set out in 5.1.6.1 Thermal resistance and 5.1.6.2 Condensation.

5.1.4 Safety in use

5.1.4.1 Impact resistance

5.1.4.1.1 Resistance to structural damage from soft body impact load – 50 kg bag

Testing of roof systems with respect to impact from a large soft body is performed as described in prEN XXXX Continuous roof lights of plastics for use with upstands, § 6.4.4.2.

In roof kits comprising repeatable units, the need for vertical and horizontal impacts is considered in relation to one unit only.

5.1.4.1.2 Resistance to structural damage from hard body impact load – 250g steel ball

Testing of roof systems with respect to impacts from a small hard body is performed as described in prEN XXX Continuous roof lights of plastics for use with upstands, § 6.4.4.1.

5.1.4.2 Shatter properties/safe breakability

The design and specification of the roof, together with the results of the impact tests described above, shall be examined. The failure mode will allow an assessment to be made of the risk of unsafe breakage.

5.1.4.3 Resistance to live horizontal loads

Walkways provided as part of some roof kits may be assessed in accordance with EN 516.
Kits may also incorporated safety hooks and anchorages for access purposes. In addition to ensuring that the roof and its connections to the structure can withstand the loads associated with the use of these devices, the devices themselves can be assessed by reference to EN 517 and EN 795.

5.1.4.4 Definition of geometry

The design and specification shall be examined. For roof kits incorporating handrails, balustrades or other similar components likely to have a bearing on limiting the risk of falling, the dimensions shall be checked and declared in the ETA. Of particular importance are the height of handrails and the spacing of bars in balustrades.

5.1.4.5 Safe opening

Where opening elements are included in a roof kit, a judgement shall be made of the hazard posed by these elements. Of particular importance are the risks of collision with these elements during operation and while in the open position and the risk of falling through while the element is open or in the act of opening.

5.1.5 Protection against noise

5.1.5.1 Sound insulation

Testing of roof systems with respect to sound insulation is performed in a laboratory as described in EN ISO 140-3.

5.1.6 Energy economy and heat retention

5.1.6.1 Thermal resistance

The following list of Standards contains references that may also be relevant to components of the roof kit; these are cross-referenced under the relevant component heading.

Calculation of the thermal insulation characteristics is performed as described in:

EN/ISO 6946, EN ISO 14683, EN 673, EN/ISO 10211-1and prEN ISO 10211-2.

The declared thermo-physical properties of the constituent materials, which will be necessary for any such calculations, shall either be as measured according to the relevant ISO listed below or alternatively be assigned a value according to ISO/DIS 10456.
The declared value shall be adjusted to design values using the procedures for the appropriate corrections for service temperature and moisture condition given in ISO 10456.
The relevant standards for thermo-physical measurements are:

EN/ISO 8990
prEN 12664
EN 674
EN 675

5.1.6.2 Condensation

The estimation of the risk of condensation, on the surface of and within the roof structure, which may give rise to mould growth or water falling or otherwise passing into the space below shall follow the procedures laid down in EN ISO 13788.

The product specifications shall be examined and performance in respect of exposure to moisture assessed on the basis of known material properties, design details and the intended use. In situations where properties such as water vapour permeability are not known they shall be determined by testing.

Testing of the water vapour permeability of materials is performed as described in prEN ISO 12572.

5.1.6.3 Air permeability

In general, testing of the air permeability is considered unnecessary. The product specifications may be examined and performance in respect of air permeability assessed on the basis of known material properties, design details and the intended use, relevant to any energy conservation measures. However, if testing is required, the method given in EN 12114 is generally applicable but with a horizontal test specimen.

5.1.6.4 Solar transmission

The transmission of solar energy into a building of which the roof kit forms part will be an important consideration, for the building's designer, in determining the resulting summertime solar load. Manufacturers wishing to include references to their product reducing such solar loads shall supply data, as required for the analysis described below, so that the transmission coefficient for their material can be estimated.

The transmittance of a transparent or translucent roof element will depend on the wavelength and angle of incidence of the solar radiation and, additionally, the refractive index, μ, and the extinction coefficient of the material; these latter parameters may be taken as effectively independent of wavelength.

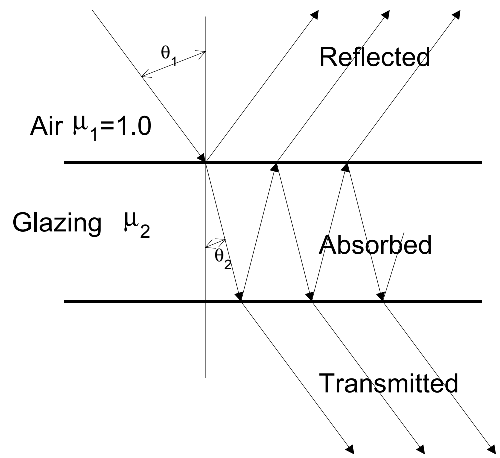


Figure 2:

The resulting transmittance of solar energy through a transparent or translucent roof element is expressed as a fraction of the incident beam intensity:

$$I_B = \tau_r \tau_a I_o$$

Where τ_r is the transmittance coefficient for reflection effects arising at each interface at which the refractive index of the material changes, and τ_a is the transmittance coefficient arising from absorption effects in the body of the material.

The total solar energy transmittance factor can be determined in accordance with the principles of EN 410.

5.1.6.4.1 Reflection transmittance

The reflection transmittance, that is the intensity reduction due to multiple reflections at n (n even) interfaces may be calculated using Fresnel's formula and the following relation. (If any interface is air, then μ =1.0)

$$\tau_{rn} = \frac{(1-\rho)}{1+(2n-1)\rho}$$

where n is the number of interfaces and ρ is given by Fresnel as:

$$\rho = \frac{1}{2}\left[\frac{\sin^2(\theta_2-\theta_1)}{\sin^2(\theta_2+\theta_1)} + \frac{\tan^2(\theta_2-\theta_1)}{\tan^2(\theta_2+\theta_1)}\right]$$

The relationship between the angles is given by:

$$\frac{\mu_1}{\mu_2} = \frac{\sin\theta_2}{\sin\theta_1}$$

If there is no specific refractive index data relating to the translucent roof material, or its coating if it has one, then either assumed generic values for known materials, or directly measured values may be used. These latter may be derived from simple normal transmission measurements of ρ conforming to ASTM D – 1003 or equivalent, from which the refractive index can be derived using the above values for ρ with θ_1= θ_2= 0.0 to give:

$$\rho = \left[\frac{\mu_1 - \mu_2}{\mu_1 + \mu_2}\right]^2$$

5.1.6.4.2 Absorption Transmittance

The solar absorption properties of the translucent roof element may be derived when the extinction coefficient for the material has either been measured, or for materials that are essentially transparent assigned for the generic material. The total energy absorption is then estimated from Bougers law. Whence:

$$\tau_{\mathrm{a}} = e^{-Et}$$

where E, the extinction coefficient for the glazing material, can be found by a series of measurements of normal transmitted intensity of solar radiation for specific thicknesses t of material and correcting for the reflection loss effect as above. Any source used in any such measurements should accurately match the solar spectrum (as defined by Moon P or later modifications as Thekaekara M P) since many polymeric materials, unlike glass, have significant transmission in the infra-red region of the spectrum. The value for E may be derived from the normal transmission fraction τ of solar radiation value through a single sheet of thickness L from:

$$E = \log_e\left[\left(\frac{1-\rho}{1+\rho}\right)\frac{1}{\tau}\right]$$

where $$\rho = \frac{\mu_2 - 1}{\mu_2 + 1}$$

5.1.7 Aspects of durability and serviceability

5.1.7.1 Resistance to corrosion and deterioration

The product specification shall be examined to determine whether the resistance to, or protection against, corrosion is appropriate for the intended use. This is dealt with in more detail in the sections dealing with the various components. The roof kit shall be examined as a whole to ensure that the materials in contact are compatible, eg contact between plasticised PVC and polycarbonate is not advisable. The overall examination should also ensure that the risk of growth of fungi or algae or infestation by insects or vermin is minimised according to conventional design principles.

Where materials of unknown composition and performance are used, where the manufacturer makes specific claims, where the location of the roof is such that cleaning is an important requirement or where the proposed external environment is recognised as aggressive eg marine or industrial, further evidence shall be presented and use may be made of documented evidence of performance, existing approvals or compliance with other standards.

Kits incorporating structured sheets may be particularly at risk from the effects of fungi, algae and the entry of insects. Adequate ventilation and screening of chambers in structured sheets must be ensured. However, see also comments on the formation of condensation on or within structured (multi-wall) sheets under 5.3.3.2.

COMPONENTS

General note on identification

All components shall be clearly identified by reference to a standard, formulation, manufacturer's specific reference or a similar unique specification.

5.2. COMPONENT / ADDITIONAL BEARING PROFILES

5.2.1 Mechanical resistance and stability

5.2.1.1 General

The load bearing capacity and suitability of the bearing profiles of a roof kit are to be determined taking account of ENV 1991 – 1 either by calculation, testing or a combination of calculation assisted by testing.

5.2.1.2 Calculation

The additional bearing profiles shall be calculated in accordance with the following, depending upon the materials used:

Eurocode 3: Design of steel structures

Eurocode 5: Design of timber structures

Eurocode 9: Design of aluminium structures

5.2.1.3 Testing

Where the additional bearing profiles cannot be calculated or where a testing approach is preferred, the profiles are normally tested during the full-scale tests on the kit, under 5.1.1.1.2
For bearing profiles of un-reinforced polymeric material, such as PVC-U, temperature, period of loading and ageing effects should be taken into account, as for the translucent sheets – see 6.3.1.2 and Annex H.

5.2.2 Safety in case of fire

5.2.2.1 Reaction to fire

The component shall be tested in order to be classified in accordance with EC Decision 2000/147/ EC and classification standard prEN 13501-1.
Products that are included in EC decisions 94/611/EC and 96/603/EC as amended by 2000/605/EC can be considered to be Euroclass A1 without testing.

5.2.3 Hygiene, health and the environment

5.2.3.1 Release of dangerous substances

See 5.1.3.1

5.2.3.2 Condensation

The determination of the risk and rate of surface condensation on frame members is considered as part of the examination of the kit.

5.2.4 Safety in use, 5.2.5 Protection against noise

Not relevant to this component

5.2.6 Energy economy and heat retention

Where a manufacturer makes specific claims for the thermal performance of a roof kit or where it is required to determine the risk of surface condensation under particular conditions, the thermal characteristics of the frame members shall be determined using relevant tests and calculations given in prEN 12412-2 and prEN ISO 10077-2.

5.2.7 Aspects of durability and serviceability

In order to demonstrate the durability and serviceability of bearing profiles, the approval body may make use of information derived from documented sources, such as listed experience, previous approval procedures etc. The file must make clear under what conditions of climate and product usage the satisfactory experience has been gained. The following references may be used:

Aluminium

Compliance of aluminium profiles with a powder or liquid applied coating with the requirements of prEN 12206 Part 1 or Part 2 respectively.

Unplasticised polyvinyl chloride

White PVC-U extrusions may be assessed against the requirements of prEN 12608.
For dark coloured profiles (through-coloured, capped or foiled) additional requirements must be taken into account. The effect of temperature is particularly important – see also 5.2.1.3. The UEAtc document *Technical Report on the Assessment of Windows in Coloured PVC-U* provides further guidance.

Steel

Steel structures may be assessed against EN ISO 14713 or EN ISO 12944

Timber

Compliance of the members of timber structures with the requirements of ENV 1995-1.5.3

5.3 COMPONENT / TRANSLUCENT SHEETS

5.3.1 Mechanical resistance and stability

5.3.1.1 General

Because of the limited available data, the load-bearing behaviour of the translucent parts of a roof kit, under downward and uplift loads, shall be examined by full-scale tests. In addition, in order to characterise the performance of the sheets themselves, a series of material specific small-scale tests is required.
Computer software is available that can be used to predict some aspects of the behaviour of translucent sheets of defined geometry. However, before such software can be used its efficacy must be validated against the results of tests.

5.3.1.2 Full-scale tests

The approach to testing shall be as used in the full-scale tests on the kit - see 5.1.1.1.2 with the important difference that when the translucent sheets are under test the bearing profiles are propped and their behaviour does not influence the behaviour of the sheets.
The tests are designed to derive data relating to:

- mid-span moment of resistance (both downward and uplift loading)

- reaction at supports

- moment of resistance at intermediate supports (both downward and (wind) uplift loading)
- local buckling and crushing resistance
- breakage (brittle fracture)
- for curved systems – maximum load (gravity, uplift and half-span load)
- failure at fixing points (slipping out)

From these data and the modification factors (Annex H) the governing mode of failure shall be determined for the actual construction being considered.

5.3.1.3 Small scale (characterisation) tests

In the characterisation tests for translucent elements, all component properties relevant to the bearing behaviour in the proposed application shall be determined. The following tests shall therefore be undertaken and may also serve as production control tests, as further detailed in Chapter 8. The overview below gives component properties relevant to various plastics:

Table 5.2:

Component Property to be tested	**Poly-carbonate (PC)**	**Polymethyl-methacrylate (PMMA)**	**Polyvinyl-chloride (PVC)**	**Laminate of textile glass-reinforced unsaturated polyester resin (GRP)**
Geometry / weight per unit area	X ◆	X ◆	X ◆	X ◆
Deformation behaviour	X ◆	X ◆	X ◆	X ◆
Break behaviour [(1)]		X ◆		X (◆)
Frozen-in strains [(2)]: a) dimensional stability	X	X ◆	X ◆	
b) impact strength	X	X	X ◆	
Heat resistance			X ◆	
Curing				X ◆
Proportion of glass (additives)				X ◆

X Tests for characterisation
◆ Possible tests for production control
(1) Only required in plastic elements for which failure in the full-scale test is due to breakage
(2) See also Fig F2.1 for a test specific to PMMA

To establish a property, in the characterisation test, at least 10 specimens are required. Unless described otherwise below, all tests shall be carried out in the standard atmosphere to EN ISO 291 - 23/50 - 2 with the relevant conditioning prior to testing. The specimens shall be taken from at least three different production batches, preferably parts of the sheets used in the full-scale tests, to ensure they are representative .

5.3.1.3.1 Tests relevant to various sheet-types

5.3.1.3.1.1 Multi-wall (webbed) Sheets

As multi-wall sheets are usually used in roof systems with additional bearing profiles and as in such systems they bear parallel and transverse to the webs, properties which are direction dependent shall be determined in both directions.

(m.1) Geometry/Weight per Unit Area

For multi-wall sheets, the external dimensions, flange and web thicknesses, web intervals, angle between webs and flanges, and the weight per unit area shall be determined. If the edges of the multi-wall sheets are formed differently from the geometry of the sheet centre, these dimensions shall be determined separately (see Annex F Fig F1.1). The measurements shall, where appropriate, be $\pm$ 0.05mm for overall thickness, $\pm$ 0.01mm for skins and webs and $\pm$ 0.1 mm for overall sheet sizes.

(m.2) Deformation Behaviour

To determine deformation behaviour, the creep bending tests based on EN ISO 899-2 shall be performed. Fig F 1.1 shows the corresponding test conditions for a typical polycarbonate multi-wall sheet. Component properties decisive for the support behaviour are the bending stiffness, shear stiffness (only relevant in the transverse direction) and the influence of the load duration. To calculate these stiffnesses, the deflection values after a load duration of 0.1 h shall be used. The effective span, L, shall be 20 times the height of the sheet. To determine the shear stiffness, the specimen shall also be tested with double the span in the transverse direction. The specimen width shall be at least 80 mm, and specimens shall have at least three webs in the longitudinal direction. The loads shall be selected such that the stress on the multi-wall sheets covers the load range in use.

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

$\{EI\}^* = (F \cdot L^3) / (48 \cdot f)$ (Bending stiffness without the influence of shear)

$\{EI\} = [F \cdot (L_1^3 - L_1 \cdot L_2^2)] / [48 \cdot (f_1 - f_2 \cdot L_1/L_2)]$ (Bending stiffness with the influence of shear)

$\{GA_Q\} = [F \cdot (L_1 - L_1^3/L_2^2)] / [4 \cdot (f_1 - f_2 \cdot L_1^3/L_2^3)]$ (Shear stiffness)

The magnification factor C_t (influence of load duration) is determined according to Annex H.

(m.3) Break Behaviour

This test, which is only relevant to brittle materials such as PMMA, shall be performed using a three-point bending procedure on test specimens in the transverse and longitudinal direction, where the break load shall be determined. The effective spans shall be 20 times the thickness and the test speed shall be such that the rate of strain of the extreme fibre does not exceed 1%. The specimen dimensions correspond to those given in (m.2). For load distribution, a rubber mat with a nominal Shore A hardness of 70 and dimensions 100 mm x specimen width x 20 mm shall be placed under the load edge (cf. ISO 12017).

Fig F 1.2 in Annex F shows schematically such a test structure with the test conditions for a multi-wall sheet.

(m.4) Dimensional Stability

The length change shall be tested after conditioning in an oven in accordance with EN 1013-3, prEN1013-4 or prEN1013-5. The specimens shall be square and have minimum dimensions 250 x 250 mm and at least 5 webs. To determine the length change, at least two measurement marks for each shall be made on the specimen at an interval of at least 200mm. After heating, the length change shall be determined and given as a percentage of the original length.

Annex F Fig F 1.3 shows, for example, the test conditions for a multi-wall sheet of PC.

(m.5) Impact Strength

The impact strength is determined on the basis of EN ISO 6603-1 on specimens of minimum dimensions 300 x 300 (in mm). The test sample shall have at least 5 webs. The test arrangement is shown in Annex F Fig.F1.4. As an indication of the impact strength, a combination of drop weight/drop height is determined at which no crack or break appears during 10 tests (white discolourations are not regarded as cracks).

(m.6) Heat Resistance

The heat resistance shall be tested for PVC elements. A test sample of minimum dimensions 250 x 250mm and of the sheet thickness shall be stored in a circulating air oven for a period of 30 minutes at a temperature of 60°C or above, depending on the material. The temperature in the oven shall be increased by 5°C at intervals of 5 minutes until the profile cross-section loses its stability and the specimen deforms greatly under its own weight. The respective failure temperature shall be determined as an indicator of the heat resistance. The test arrangement is shown in Annex F Fig. F1.4 schematically, as an example for a PVC multi-wall sheet.

5.3.1.3.1.2 Flat solid sheets

Flat (non- profiled) sheets are usually used in roof systems with additional bearing profiles as for multi-wall sheets (see fig. B 1.2.1 and B 1.2.2). Depending on the method of manufacture (e.g. extrusion or bi-axial stretching) the sheets may have direction-dependent properties. In the following tests, this direction dependence shall be taken into account.

(f.1) Geometry
For flat solid sheets, the external dimensions (±0.1mm) and thickness (±0.05mm) shall be determined.

(f.2) Deformation Behaviour
To determine the deformation behaviour, creep bending tests based on EN ISO 899-2 or EN 63 shall be performed. The test samples shall have a width of 50 mm ± 0.1mm.The effective span shall be 20 times the specimen thickness. The magnification factor C_t (Annex H) and the deflection value after 0.1 h load duration shall be determined.

(f.3) Break Behaviour
To assess the break behaviour, three-point bending tests based on EN ISO 178 shall be performed. The test samples and test arrangement shall be as for (f.2) above.

(f.4) Dimensional Stability
The method given in (m.4) shall be applied.

(f.5) Impact Strength
The impact strength is determined according to para (m.5) above.

(f.6) Curing and Glass Proportion
For solid sheets of GRP, the curing and proportion of glass shall also be determined. The curing can be assessed from the creep-bending test in accordance with (f.2) above. For this, the creep modulus E_c is calculated from the deflection after 1 h and after 24 h as follows:

$$E_c = E_{1h} \cdot \frac{(f_{1h})^{3.6}}{(f_{24h})}$$

The glass proportion is determined in accordance with EN 60

5.3.1.3.1.3 Hollow chamber profiles

Hollow chamber profiles bear mainly in one direction (see fig. B 1.3.1,B 1.3.2 and B 1.4) and direction-dependent properties need only be determined in the main bearing direction.

(h.1) Geometry / Weight per Unit Area
For hollow chamber profiles, the external dimensions, flange and web thicknesses, web intervals, angle between web and flanges, dimensions in the connecting area and the weight per unit area shall be determined.

(h.2) Deformation Behaviour
To determine the deformation behaviour, creep-bending tests shall be performed to Fig. F 3.1. The specimen shall have full profile width. A test span of 20 times the profile height is preferred. The magnification factor C_t (Annex H) and the deflection value after 0.1 h load duration shall be determined from the tests.

h.3) Break Behaviour

The failure of roof kits with hollow chamber profiles is generally due to deformation. However if the break behaviour is decisive, the break moment shall be determined with the test arrangement in Annex F Fig F1.2

(h.4) Dimensional Stability

The dimensional stability of hollow chamber profiles shall be determined in accordance with (m.4) above.

(h.5) Impact Strength

The impact strength shall be determined in accordance with (m.5) above on test samples having the full profile width.

(h.6) Heat Resistance

Test in accordance with (m.6) above.

5.3.1.3.1.4 Profiled (corrugated) sheets

Profiled sheets for single skin roofing span mainly in one direction as for hollow chamber profiles; therefore direction-dependent properties are to be determined only in main span direction.

(pr.1) Geometry / Weight per Unit Area

All dimensions necessary for a complete description of sheet geometry (see EN 1013-1) shall be determined. The weight per unit area of the sheets shall also be determined.

(pr.2) Deformation Behaviour

To determine the deformation behaviour, creep-bending tests shall be carried out on the test samples that have at least one symmetrically repeating width of cross-section, but at least two ribs. A test span of 20 times the profile height is preferred (minimum normally 800mm). The test arrangement for the creep bending test shall be such that the load is applied to the extruded cross-section parts and the profile geometry remains largely constant at the ends of the specimen (see auxiliary constructions from ENV 1991-1-3 (Eurocode 3)). Fig F4.1 shows, as an example, such a creep-bending test on a trapezoidal profile. This test can be used for production control purposes taking a deflection value after a load duration of 0.1h, for the determination of C_t (see also Fig H.8 and related text) and for the determination of creep deflection [see (pr7) for GRP]

(pr.3) Break Behaviour

If the break behaviour is decisive for the load-bearing capacity of the profile in the full-scale test, short-term break tests shall be carried out with the test structure shown in Annex F Fig F1.2 and the break loads determined.

(pr.4) Dimensional Stability

The dimensional stability is determined for PVC, PC and PMMA on the basis of EN 1013-3, prEN 1013-4 and prEN 1013-5 respectively. The length changes in the longitudinal and transverse directions shall be determined.

(pr.5) Impact Strength

The impact strength shall be determined to Annex F Fig F 4.2 on the basis of EN 1013-1.

(pr.6) Heat Resistance

To determine the heat resistance, the tests in accordance with (m.6) shall be performed. The failure temperature is the temperature at which at least one high point of the profile touches the glass sheets.

(pr.7) Curing and Glass Content (GRP only)

For profiled sheets of GRP, the curing and proportion of glass shall be determined. As an indication of the curing, in the creep bending test (see pr.2), the creep deflection f_c is calculated from the following equation:

$$f_c = f_{1h} \cdot \left(\frac{f_{24h}}{f_{1h}} \right)^{3.6}$$

5.3.2 Safety in case of fire

5.3.2.1 Reaction to fire

The component shall be tested in order to be classified in accordance with EC Decision 2000/147/ EC and classification standard prEN 13501-1.
Products that are included in EC decisions 94/611/EC and 96/603/EC as amended by 2000/605/EC can be considered to be Euroclass A1 without testing.

5.3.3 Hygiene, health and the environment

5.3.3.1 Release of dangerous substances

See 5.1.3.1

5.3.3.2 Condensation

The determination of the risk and rate of surface condensation on translucent sheets is considered as part of the assessment of the kit

It must be noted that condensate can form on the external and/or internal surfaces of multi-wall translucent sheets. Condensation first appears in the form of fine droplets that scatter the light and makes the fogged areas appear white. This fogging reduces light transmission but has virtually no effect on other properties of the sheets (including heat insulation). The formation of condensation in this way is not a property of the multi-wall sheet, but depends solely on the physical conditions (temperature, humidity, dew point) at the surface of the sheet.

5.3.4 Safety in use

See 5.1.4

5.3.5 Protection against noise

Not relevant to this component

5.3.6 Energy economy and heat retention

Where a manufacturer makes specific claims for the thermal performance of a roof kit or where it is required to determine the risk of surface condensation under particular conditions, the thermal characteristics of the translucent sheets shall be determined using relevant tests and/or calculations given in the standards listed in 5.1.6.1.

5.3.7 Aspects of durability, serviceability and identification

This Guideline covers primarily sheets made from glass reinforced polyester resin (GRP),
(poly)vinyl chloride (PVC), polycarbonate (PC), and (poly)methyl methacrylate (PMMA). The approval body may judge the suitability of the tests described for other translucent materials.

5.3.7.1 Durability

5.3.7.1.1 Testing

- Light transmittance

The light transmission of the translucent material is determined as luminous transmittance τ_{D65} using a spectrophotometer according to ISO 13468. To determine values for the combination of several sheets multiply the individual values measured or calculate the light transmittance of the combination as described in ISO 9050.

The light transmission of multi-skin sheets is determined as luminous transmittance τ_A according to ISO 9050.

Alternatively, multi-skin sheets can be regarded and tested as a combination of single sheets after removing the ribs.

- Accelerated ageing

The testing shall be undertaken according to ISO 4892-1. The spectral distribution of the filtered xenon arc radiation shall be in accordance with ISO 4892-2.

The following test conditions shall be observed:

- black-panel temperature 45±3 °C
  or
- black standard temperature 65±3 °C
- air temperature in the test chamber 30 to 35 °C
- relative humidity in the dry period 65±5%
- time of spraying 18min + 102min dry interval [1]

The duration of the test shall be determined so as to fulfil one of the following levels:

- level 0[2] : ≥ 18GJ/m^2
- level 1 : ≥ 10GJ/m^2
- level 2 : ≥ 6 GJ/m^2
- level 3 : ≥ 4 GJ/m^2

The dimensions of the test samples shall be sufficient to be subsequently tested for light transmittance, yellowness index, and mechanical properties.
Test specimens for these tests shall be representative and not thicker than the sheets used in practice.

[1)] Where these facilities are not available, times of 9 min and 51 min, respectively, are acceptable.
[2] A manufacturer may request the use of a higher level of irradiation to suit particular market requirements – this shall be declared, see 6.3.7

- Change of light transmittance

Apparatus

The light transmittance shall be determined using a spectrophotometer as described above before and after the ageing procedure.

Test pieces

Ten test pieces shall be used, in order to be representative.

Procedure

Calibrate and operate the spectrophotometer and other instruments in accordance with instructions supplied by the manufacturer.

Obtain spectral transmittance data relative to air in the wavelength range of 380 to 780 nm.

Expression of results

The change of light transmission is expressed as the average of the variation of total luminous transmittance of the test pieces. These figures are evaluated as a percentage of the initial value.

- **Change in yellowness index**

Apparatus

Determine the yellowness index using a spectrophotometer as described for determination of light transmission, before and after the ageing procedure.

Test pieces

The same test pieces are used as for change in light transmittance.

Procedure

Calibrate and operate the spectrophotometer and other instruments in accordance with instructions supplied by the manufacturer.
Obtain spectral transmittance data relative to air in the wavelength range of 380 to 780 nm.

Expression of results

Calculate the tristimulus values for source C by numeric integration from recorded spectral data or by automatic integration during spectrophotometer operation.

Calculate the magnitude and sign of the yellowness index from the following equation:

$$YI = \frac{100\,(1.28.X_{CIE} - 1.06.Z_{CIE})}{Y_{CIE}}$$

Calculate the magnitude and direction of change in yellowness index from the following equation:

$\Delta YI = YI - YI_o$

- **Change of mechanical properties**

The bending strength and the corresponding E-modulus shall be measured according to EN 63 or EN ISO 178, before and after the accelerated ageing.
If a bending test cannot be performed, the tensile strength and corresponding E modulus shall be measured according to EN ISO 527 – 1 and 2 before and after the accelerated ageing.
Test specimens for these tests shall not be thicker than in practice. Ten test pieces are used for evaluation, five before and five after the ageing procedure; the average is compared.
Bending or tensile and light transmission tests shall be carried out on the same sample ensuring the aged surface is in tension.

5.3.7.2 Serviceability

5.3.7.2.1 Hail resistance

In addition to the tests described for impact resistance, light transmission and yellowness index, it may be necessary, if special claims are made by the manufacturer, to determine the hail resistance of the translucent sheets. This may be undertaken and the results determined in accordance with sections 5.3.2 and 6.3 of EN 1013 – 1: 1997. This test is optional.

5.3.7.2.2 Effect of chemicals and materials in contact

Thermoplastic translucent sheets can suffer deterioration due to contact with acids alkalis and solvents, particularly when, in service, they are under stress due eg to cold forming. The sheets can be at risk due to chemicals in the environment eg from adjacent roofs, those in cleaning materials and those contained in materials in contact.

Contact between gaskets of plasticised PVC and PC sheets should normally be avoided in the kit, as there is a risk of plasticiser migration and a subsequent risk of stress cracking of the PC sheet.
The method described in Annex B to EN ISO 12017 may be used to examine the effect of chemicals and materials in contact, eg sealing gaskets. The actual chemicals to be used must be determined by the Approval Body and will depend upon the proposed use of the roof kit and the claims made by the manufacturer.

5.3.7.3 Identification

In addition to the sheet manufacturers code and material designation, the geometry/weight per unit area, referred to in Table 5.2, shall be used for the purposes of identification of translucent sheets.

5.4 COMPONENT /SEALS AND GASKETS

5.4.1 Mechanical resistance and stability

Not relevant to this component

5.4.2 Safety in case of fire

5.4.2.1 Reaction to fire

The component shall be tested in order to be classified in accordance with EC Decision 2000/147/ EC and classification standard prEN 13501-1.
Products that are included in EC decisions 94/611/EC and 96/603/EC as amended by 2000/605/EC can be considered to be Euroclass A1 without testing**.**

5.4.3 Hygiene, health and the environment

5.4.3.1 Release of dangerous substances

See 5.1.3.1

5.4.4 Safety in use, 5.4.5 Protection against noise, 5.4.6 Energy economy and heat retention

Not relevant to this component

5.4.7 Aspects of durability and serviceability

Seals and gaskets shall comply with ISO/DIS 3934, which provides a classification system for vulcanised rubber and thermoplastic materials.

5.5 COMPONENT/ FIXINGS

5.5.1 Mechanical resistance and stability

The characteristics of the fixings will normally be tested either as part of the kit /system under clause 5.1.1 or in conjunction with the translucent sheets under clause 5.3.1.
If sufficient evidence is not available from these tests, then the pull-out and shear strength of the fasteners shall be tested according to the principles of the test method indicated in Annex G.

Precise details for the test and test specimen are not possible due to the wide variety of fixing configurations. Care is needed in the design of the test specimen to reflect properly the actual loading conditions and to avoid unwanted eccentricity of loading.

Determination of a representative sample and test set-up is carried out by the approval body in co-operation with the applicant and is based on the experience of the approval body.

5.5.2 Safety in case of fire

Not relevant to this component

5.5.3 Hygiene, health and the environment

5.5.3.1 Release of dangerous substances

See 5.1.3.1

5.5.4 Safety in use, 5.5.5 Protection against noise, 5.5.6 Energy economy and heat retention

Not relevant to this component

5.5.7 Aspects of durability

5.5.7.1 Metallic Fasteners

The test described in this chapter shall be carried out on any fasteners including metal parts, unless they are made from materials which have been proven to be resistant to corrosion. Thus, any fastener including metal components not composed of 1.4301 or 1.4401 austenitic stainless steel, according to EN 10088 shall be subjected to this test.

Determination of the corrosion behaviour of fasteners is made by testing in accordance with ISO 6988:1995 - Testing in alternating atmosphere containing sulphur dioxide - on a total of 10 fasteners.

The fasteners are to be incorporated into the roof system, as in practice, according to the specifications of the fastener manufacturer. The fasteners are installed in a substrate corresponding to the use of the fastener. This need not be a full roof construction but an assembly suitable for testing purposes only. The length of the fastener that passes through or is embedded in the substrate must be measured individually for each fastener and noted.

The fasteners are removed from the test assembly without causing further damage to the coating. This is facilitated by either cutting through the substrate, or - if unscrewing - ensuring that the fastener and washer are removed as a single item (i.e. that the screw thread does not spin in the washer)

The fasteners are subjected to 15 exposure cycles in an alternating humid atmosphere containing 2 litres of sulphur dioxide, concentration SFW 2.0 S in accordance with DIN 50018:1997.

The test specimens are to be arranged centrally in the test chamber by suspending them vertically by the use of an inert thread, such as nylon, with a minimum spacing of 20 mm between them. Only test specimens of the same type are to be used for each test, to rule out test specimens with different corrosion protection systems affecting each other. Washers (in the case of point fasteners); profiles (in the case of linear fasteners); and fastener shafts are to be arranged in the test chamber separately from each other. In order to compensate for the small surface area of the fasteners a galvanised steel blanking plate should be included to achieve the minimum surface test area of $0,5 \pm 0,1$ m^2.

The test specimens are exposed to the effect of condensation from water to which 2 litres of sulphur dioxide ($S0_2$) has been added. The 2 litres of sulphur dioxide ($S0_2$) are charged immediately after the test chamber is closed. The heating is switched on to reach a test temperature of 40 ± 3°C in 95 ± 5 minutes. One cycle comprises two test stages and lasts for a total of 24 hours. In the first test stage, totalling 8 hours (after the heating is switched on), the test specimens are exposed at 40 ± 3°C to the condensation and the sulphur dioxide. The second test stage begins when the heating is switched off and the test chamber is opened or ventilated. The test specimens are to be left in the chamber, where drying will take place over 16 hours. After the second test stage, the base tank of the test chamber is emptied, cleaned if necessary, and filled with fresh distilled or de-ionised water. The test chamber is closed and charged with sulphur dioxide. A new cycle begins when the heating is switched on,

When the 15 cycles have been completed, the test specimens are removed from the test chamber and examined for surface corrosion (rusting). Any corrosion, which may have formed beneath the corrosion protection coating, is also to be recorded. If it is clear that the requirements of § 6.3.7.1 cannot be achieved before the 15 cycles are completed, the result is considered unsatisfactory and the test may be terminated.

The head of the fastener, the part of the fastener which has passed through the substrate and the rim around the external edges of the washer are not included in the determination of surface corrosion. Visual evaluation is made. In borderline cases, the evaluation shall be undertaken by 3 people, independently of each other.

6. ASSESSING AND JUDGING OF THE FITNESS FOR USE OF PRODUCTS FOR AN INTENDED USE

This Chapter details the performance requirements to be met by a roof system (chapter 4) into precise and measurable criteria (as far as possible and proportional to the importance of the risk) or qualitative terms, related to the products and their intended use, using the outcome of the verification methods (chapter 5).

Where a kit has been assessed for use under sustained low temperature conditions, this shall be taken into account in expressing the results.

The possible ways of expressing the results of the assessment of the mandatory performance requirements are shown in the following table 6.1:

Table 6.1:

ER	ETAG paragraph on product performance to be assessed	Class Use category Numeric value
1	6.1.1(SYSTEM) Mechanical resistance and stability 6.2.1, 6.3.1, 6.5.1 (COMPONENTS) Mechanical resistance and stability	Declaration of mechanical properties
2	6.1.2. (SYSTEM)	No performance determined option (for all or any characteristic) - may be covered by a ‘Class’
	6.1.2.1External fire performance	Pass/fail (for each test method)
	6.1.2.2Reaction to fire	Euroclasses A_1 – F
	6.1.2.3 Resistance to fire	Euroclasses RE and REI
		For products offering smoke and heat ventilation: B_{300}, B_{600}
	6.2.2,6.3.2,6.4.2,6.5.2 (COMPONENTS) 6.2.2.1,6.3.2.1,6.4.2.1,6.5.2.1 Reaction to fire	No performance determined option (Class) Euroclasses A_1 - F
3	6.1.3 (SYSTEM) 6.1.3.1Release of dangerous substances 6.2.3,6.3.3,6.4.3,6.5.3 (COMPONENTS) 6.2.3.1,6.3.3.1,6.4.3.1,6.5.3.1 Release of dangerous substances	Indication of harmful materials “No harmful materials”
	6.1.3(SYSTEM) 6.1.3.2 Watertightness and presence of dampness 6.1.3.2.1 Resistance to wind driven rain and snow 6.1.3.2.2 Condensation	Resistant to the ingress of water: Categories where tested or qualitative assessment Assessment of performance
	6.1.3(SYSTEM) 6.1.3.2.2 6.2.3 , 6.3.3(COMPONENTS) 6.2.3.2 , 6.3.3.2 Condensation	No performance determined option Condensation risk for defined class of building use. Description of risk of growth of any fungi and other micro-organisms

4	6.1.4(SYSTEM) 6.1.4.1 Impact resistance 6.1.4.2 Shatter properties/safe breakability 6.1.4.3. Resistance to live horizontal loads 6.1.4.4 Definition of geometry 6.1.4.5 Safe opening	Large soft-body Declaration of Category, as tabled. Hard-body Pass/fail (with comment) No performance determined option or numerical value/dimension " "
5	6.1.5(SYSTEM) Sound insulation	No performance determined option Single number rating
6	6.1.6(SYSTEM) 6.1.6.1 6.2.6 , 6.3.6.(COMPONENTS) Thermal resistance 6.1.6.2 Condensation 6.1.6.3 Air permeability 6.1.6.4 Solar transmission	No performance determined option Measured or calculated value No performance determined option Water vapour permeability of materials No performance determined option Measured value No performance determined option Measured values
Aspects of durability serviceability and identification	6.1.7 (SYSTEM) 6.2.7 , 6.3.7 , 6.4.7 , 6.5.7(COMPONENTS)	Corrosion resistance/ protection Preservative treatment(as relevant) Change of light transmittance Change of yellowness index Change of mechanical properties Resistance to chemicals Dimensions and geometry

6.1 KITS / SYSTEMS

6.1.1 Mechanical resistance and stability

6.1.1.1 General

The objective is to determine the resistance of the assembled roof, constructed from the kit, against upward load, downward load and, where relevant, half-load (eccentric load). Most manufacturers will offer a range of bearing profiles and sheet thicknesses to cover the range of loading conditions likely to be encountered. A particular bearing profile section and, in curved systems, a given radius of curvature will normally accommodate a number of different sheet thicknesses.
Determination of the overall resistance will depend on the method of verification adopted from Chapter 5. The performance of the kit/system or a component may govern.

The following criteria/cases shall be assessed:

(a) load bearing performance of the bearing profiles:
- positive and negative moments
- bearing
- deflections

For bearing profiles of un-reinforced polymeric material, such as PVC-U, factors should be applied to the test results to take account of temperature, period of loading and ageing effects, as for the translucent sheets – see 6.3.1.2 and Annex H.

(b)* load bearing performance of the translucent sheets, adjusted as relevant for temperature, period of loading and ageing effects (see 6.3.1.2 and Annex H):

– mid span positive and negative moments
– moments at supports, if appropriate
– bearing
– deflection
– interaction between bending and support reaction, if appropriate.

*This is relevant also to consideration of the case where the bearing profiles and sheets are tested together in one test – see 5.1.1.1.2 (c)

(c) load bearing performance of the fixings:

– pull out (pull through)
– shear

6.1.1.2 Racking resistance (of the roof)

Where racking strength and stiffness values have been determined by test, in accordance with 5.1.1.2 these shall be declared in terms of resistance per unit length of roof element.

6.1.2 Safety in case of fire

6.1.2.1 External fire performance

The product shall be classified in accordance with EC Decision 2001/671/ EC and classification standard prEN 13501-5
The ETA shall either indicate the classification or state "No performance determined"

6.1.2.2 Reaction to fire

The product shall be classified in accordance with EC Decision 2000/147/ EC and classification standard prEN 13501-1

6.1.2.3 Resistance to fire

The product shall be classified in accordance with EC Decision 2000/367/ EC and classification standard prEN 13501-2

The natural smoke and heat ventilators are evaluated for their ability to open and provide for the ventilation of smoke and heat, driven only by the buoyancy of hot gases from the fire. The following range of classification for Natural Smoke and Heat Ventilators shall be used in accordance with the classification given in prEN 12102-2, Chapter 7

B_{300} (tested with hot gases of 300°C)
B_{600} (tested with hot gases of 600°C)

6.1.3 Hygiene, health and the environment

6.1.3.1 Release of dangerous substances

The kit and all its components shall comply with all relevant European and national provisions applicable for the uses for which it is brought to the market. The attention of the applicant should be drawn to the fact that for other uses or other Member States of destination there may be other requirements which would have to be respected. For dangerous substances contained in the product but not covered by the ETA, the NPD option (no performance determined) is applicable.

6.1.3.2 Watertightness and presence of dampness

6.1.3.2.1 Resistance to wind driven rain and snow

A qualitative declaration of performance shall be made based on the basis of known performance under defined conditions **or** the performance of the roof kit shall be categorised as a result of the tests under 5.1.3.2.1:

Table 6.2: Watertightness categories.

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

6.1.3.2.2 Condensation

The assessment of this requirement is carried out as described in clause 6.1.6.2. Even if the roof system is not intended to fulfil the requirements under ENERGY ECONOMY AND HEAT RETENTION, clause 6.1.6.2 is still the basis for the assessment of this requirement.

The results of assessment or tests shall be used to describe the roof system's resistance to the growth of fungi and other micro-organisms as a function of ambient temperature and relative air humidity and the effects of (temporary) condensation.

6.1.4 Safety in use

Several aspects of performance are assessed; some of which are concerned with the interaction with ER1 (Cf. Section 6.1.1) and others that are concerned only with this Essential Requirement.

6.1.4.1 Impact resistance

6.1.4.1.1 Resistance to structural damage from soft body impact load – 50-kg bag

When tested in accordance with 5.1.4.1.1, and according to their resistance to impact load of large soft body, roof kits are categorised as in Table 6.3.

Table 6.3: Large soft body impact load categories

Category	Impact Energy Vertical impact [J]	Impact Energy Horizontal impact [J]
SB 1200	1200	900
SB 800	800	600
SB 600	600	450
SB 300	300	225
SB A*	A	0,75 x A
SB0	No requirement	No requirement

* The value of A can be selected to meet specific requirements.

6.1.4.1.2 Resistance to structural damage from hard body impact load – 250g steel ball

The hard body impact load with the 250 g steel ball represents the action from heavy non-deformable objects such as tools or equipment which by accident hit the roof when being used, during maintenance of the roof or adjacent structures. ‘No performance determined’ is not an option. When tested in accordance with 5.1.4.1.2 no penetration shall be acceptable. In the case of multi-walled sheets this refers to penetration of all walls of the sheet. If penetration of the outer wall occurs, this must be considered in relation to its effect on weather tightness and/or durability.

6.1.4.2 Shatter properties/safe breakability

The shatter properties of the translucent elements shall be described in qualitative terms, based on the result of impact tests. Where a roof system incorporates elements liable to failure by brittle fracture, provision to prevent the debris posing a risk to occupants of the building may need to be incorporated to reduce such a risk to an acceptable level, that is no greater than is commonly accepted.
If the system allows for the incorporation of measures for protection in case of breakage, this shall be mentioned in the ETA.

6.1.4.3 Resistance to live horizontal loads

Walkways, safety hooks and anchorages for access purposes shall be described and their performance characterised as given in the standards referred to in 5.1.4.3. A ‘no performance determined’ option is possible.

6.1.4.4 Definition of geometry

The dimensions referred to in 5.1.4.4 shall be given in the ETA. A ‘no performance determined’ option is possible.

6.1.4.5 Safe opening

For kits incorporating opening parts, dimensional details shall be given in the ETA, together with a qualitative judgement of the hazard posed by such elements, as set out in 5.1.4.5
The variety of designs is such that the Approval Body must judge whether any hazard is present. In most cases, with a roof at high level and with access only for maintenance, the risk is minimal. A ’No performance determined’ option is possible.

6.1.5 Protection against noise

6.1.5.1 Sound insulation

The measured airborne sound insulation is expressed as a single number rating, R_w, in accordance with EN ISO 717-1. A ‘no performance determined’ option is possible.

6.1.6 Energy economy and heat retention

6.1.6.1 Thermal resistance

The calculated or measured value of the thermal resistance (R-value) in m^2 K/W or thermal transmittance (U value) in W/(m^2 K) is given.

The effect of any areas of thermal bridging shall be included as a weighted area resultant for the total system based on its R-value calculated in accordance with the rules in EN/ISO 10211 Part 1.

6.1.6.2 Condensation

The results of the assessment undertaken under 5.1.6.2 shall be declared qualitatively or, where calculations have been undertaken, statements shall be made regarding the potential risk of condensation in relation to in-use temperature and relative humidity conditions.

It shall be required that water vapour diffusion will not occur at all or will occur only to an extent where no damage is caused during the condensation period and that the condensation is of a temporary nature. The severity of any temporary condensation shall be assessed to be less than that which may cause condensate to fall or otherwise pass into the building below.

6.1.6.3 Air permeability

Declaration of the degree of air permeability will normally be in qualitative terms, ie that the kit will provide adequate airtightness in relation to the intended use, incl. climatic zones, taking into account energy economy and heat retention, risk of cold draughts and risk of condensation within the construction

If the assembly has been tested in accordance with EN 12114 the results of the standard test shall be given.

6.1.6.4 Solar transmission

General Considerations

The verification methods described in section 5.1.6.4 may be used to assess the contribution the assembled roof may make to the illuminance of the building into which it is incorporated and the extent to which solar heating effects in the glazing are accommodated by the design of the support system. The contribution of the glazing to the buildings summertime solar load and wintertime heating may also be made.

6.1.6.4.1 Illuminance

In general, both the geometry and the extinction coefficient (E) values for the glazing will determine the illuminance possible from a particular product. In general, clear glazing should have extinction coefficients < 10, higher values will be detectable as coloured. The ETA should state, where relevant, that E > 25 and/or those parts of the glazing which have solar incidence angles > 70° will make a significantly lower contribution to the buildings illuminance, than the equivalent area of ‘clear’ glazing.

6.1.6.4.2 Glazing summertime temperatures

Glazing materials with extinction coefficients > 100 will have substantially higher summertime service temperatures (50°C+) than low absorption glazing. This should be considered in relation to the temperature factors for the translucent sheets under 6.3.1.2.

6.1.6.4.3 Building solar load

Glazing which has extinction coefficients > 100 will contribute significantly to reducing the solar load entering a building space, compared to a low absorption transparent glazing of the same dimensions. This should be noted, where applicable, in the ETA.

6.1.7 Aspects of durability, serviceability and identification

6.1.7.1 Resistance to corrosion and deterioration

The kit shall be clearly identified; where possible reference shall be made to European standards.
Based on the criteria set out in 5.1.7.1 the durability and serviceability of the kit shall be described and attention drawn to any aspects where special precautions are necessary, for example in relation to installation, cleaning or compatibility of components.

COMPONENTS

6.2 COMPONENT / ADDITIONAL BEARING PROFILES

6.2.1 Mechanical resistance and stability

6.2.1.1 General

The performance of the bearing profiles will have been determined by calculations, testing or a combination of calculation and testing

6.2.1.2 Calculation

Where the performance of the bearing profiles has been determined by calculation in accordance with the relevant structural Eurocodes (see 5.2.1) the bearing, bending and shear capacities together with predictions for deformations shall be determined. Any “boxed” values used shall be declared.

6.2.1.3 Testing

Where the performance of the bearing profiles has been determined by testing or a combination of calculation and testing, then the principles of the relevant structural Eurocodes shall be followed to determine an overall performance relating to strength and stiffness.

The statistical analysis of the test results to determine the characteristic value R_k is to be undertaken according to ENV 1991-1 (Eurocode 1) appendix D for the method a) (“Definition by the characteristic value“). For that, a logarithmic normal spread for the values determined can be assumed. In each case the 5% fractile shall be determined with a probability of W = 0.75 for unknown standard deviation σ.

6.2.2 Safety in case of fire

6.2.2.1 Reaction to fire

The product shall be classified in accordance with EC Decision 2000/147/ EC and classification standard prEN 13501-1.

6.2.3 Hygiene, health and the environment

6.2.3.1 Release of dangerous substances

See 6.1.3.1

6.2.3.2 Condensation

Considered in relation to the kit.

6.2.4 Safety in use, 6.2.5 Protection against noise

Not relevant to this component

6.2.6 Energy economy and heat retention

Where necessary, this aspect is considered as part of the condensation analysis above.

6.2.7 Aspects of durability, serviceability and identification.

The technical file and the ETA shall contain details of the bearing profile materials and the means by which their durability has been proven. Where the evidence is from previous assessments or from experience it shall be clear over what period the evidence has been gathered and under what circumstances the material and/or its corrosion protection or preservative treatment has proved satisfactory. Comment shall be made on any hazard that might arise in particular exposure conditions eg marine or industrial areas.

6.3 COMPONENT / TRANSLUCENT SHEETS

6.3.1 Mechanical resistance and stability

6.3.1.1 Design Resistance

Where applicable, the results of the tests in 5.3.1 can be analysed statistically to ENV 1991-1 (Eurocode 1) Annex D with the assumption of a logarithmic normal distribution. In each case the 5% and 95% fractile shall be determined with a probability of W = 0.75 for unknown standard deviation. Depending on their influence on the load-bearing capacity, the fractiles shall be defined as minimum and maximum values for possible production control tests.

The design resistance shall be determined using the following term (see also 6.3.1.2 and Annex H):

$R_d = \eta_{dC} \cdot R_k / \gamma_{MR}$ or $R_d = \eta_{dK} \cdot R_k / \gamma_{MR}$ for load bearing capacity

and

$C_d = \eta_{dC} \cdot C_k / \gamma_{MC}$ for serviceability

where

η_{dC} : material factor depending on the magnification factors for the design situation (for failure caused by deformation)
η_{dK} : material factor depending on the reduction factors for the design situation (for failure caused by breaking)

R_k : characteristic value of the resistance for the limit of load bearing.
C_k : characteristic value of the resistance for the serviceability limit.

γ_{MR} : partial safety factors for the material/structure in accordance with the uncertainty of the model used, with $\gamma_{MR} = \gamma_{Rd} \cdot \gamma_{mK}$ for the load bearing capacity.

γ_{MC} : partial safety factor for the material/structure in accordance with the uncertainty of the model used, with $\gamma_{MC} = \gamma_{Rd} \cdot \gamma_{mC}$ for serviceability.

For the uncertainty of the model used the partial safety factor can be set to
γ_{Rd} = 1,05

The partial safety factor γ_m for the material/structure property can be determined using the following term:

$$\gamma_{mC} = e^{(\alpha_R . \beta_C - k)v} \quad \text{or} \quad \gamma_{mK} = e^{(\alpha_R . \beta_K - k)v}$$

The weight factor, α_R , can be set to 0,8

The reliability index, β,can be set, <u>for the limit state of load bearing</u>, to:
β_K = 4,2

and, <u>for the limit state of serviceability</u>, to:
β_C = 2,5.

These values are valid for the conditions where the possible consequences of risks are:

For serviceability:

- low economic consequences, low effect on use and

For load-bearing capacity:

- no risk for human life and low economic consequences.

The fractile factor k can be taken as

$$k = 1.645$$

to determine the resistance of the structure based on the 5% fractile.

The variation coefficient v shall be based on the standard deviation of the logarithmic values (not lower than v = 0.1).

6.3.1.2 Magnification and Reduction Factors

Depending on the type of failure of the translucent sheet (or, where relevant, another polymeric material), whether due to deformation or to exceeding the material strength, the material-dependent magnification factors C_t, C_u, C_θ shall be taken into account for deformation or the reduction factors K_t, K_u, K_θ for the breaking strength. The derivation of these factors is fully described in Annex H.

C_t, K_t take into account the duration of effect for the design values, determined in relation to the time for which the effect was imposed during the component tests.

Factors C_u, K_u are applied to take into account ageing and environmental influences.

Temperature influences in the use of the roof kit in relation to the test temperatures shall be accounted for by the factors C_θ, K_θ.

If the ultimate or serviceability limit states are governed by deflections of the material/structure then factor η_d can be determined by:

$$\eta_{dC} = 1 / (C_t \cdot C_u \cdot C_\theta)$$

If the ultimate or serviceability limit states are governed by material strength then factor η_d can be calculated by:

$$\eta_{dK} = 1 / (K_t \cdot K_u \cdot K_\theta)$$

6.3.2 Safety in case of fire

6.3.2.1 Reaction to fire

The product shall be classified in accordance with EC Decision 2000/147/ EC and classification standard prEN 13501-1.

6.3.3 Hygiene, health and the environment

6.3.3.1 Release of dangerous substances

See 6.1.3.1

6.3.3.2 Condensation

The determination is considered as part of the kit. However, it may be considered advisable to note, in the ETA, the points made in 5.3.3.2 regarding surface and internal condensation in multi-wall sheets.

6.3.4 Safety in use

See 6.1.4

6.3.5 Protection against noise

Not relevant to this component

6.3.6 Energy economy and heat retention

When tested or assessed in accordance with 5.3.6, the measured or calculated numerical value for thermal conductivity, resistance or transmittance of the sheet shall be presented.

6.3.7 Aspects of durability, serviceability and identification.

6.3.7.1 Durability

- After completion of the ageing procedure, light transmission shall be maintained at a minimum level of 85% of the original value.

- Yellowness index shall not vary by more than 20%.

- The relevant mechanical properties (for reinforced and non-reinforced materials) shall be given before and after ageing.

Four categories of exposure, with a spectral distribution of 1120 W/m^2 as given in ISO 4892 are applicable, according to the level of sun irradiance:

- A_0 : $18GJ/m^2 \leq E^{(*)}$
- A_1 : $10GJ/m^2 \leq E < 18GJ/m^2$
- A_2 : $6GJ/m^2 \leq E < 10GJ/m^2$
- A_3 : $4GJ/m^2 \leq E < 6GJ/m^2$

(*) Where a level $>18GJ/m^2$ has been used, the value shall be given to allow the designer to determine suitability in particularly exposed areas.

6.3.7.2 Serviceability

6.3.7.2.1 Hail resistance

Where the hail resistance of the sheets has been tested in accordance with 5.3.7.2.1, the results shall be given on a Pass/Fail basis.

6.3.7.2.2 Effect of chemicals and materials in contact

The chemicals with which resistance has been tested in accordance with 5.3.7.2.2, or for which long-term performance is known from experience, shall be listed. If there are particular chemicals where it is known there is a potential compatibility hazard (possibly under conditions of stress in service) this shall be stated.

6.3.7.3 Identification

6.3.7.3.1 Dimensions and geometry

The critical dimensions shall be given using diagrams, as necessary.

6.4 COMPONENT / SEALS AND GASKETS

6.4.1 Mechanical resistance and stability

Not relevant to this component

6.4.2 Safety in case of fire

6.4.2.1 Reaction to Fire

The product shall be classified in accordance with EC Decision 2000/147/ EC and classification standard prEN 13501-1.

6.4.3 Hygiene, health and the environment

6.4.3.1 Release of Dangerous Substances

See 6.1.3.1

6.4.4 Safety in use, 6.4.5 Protection against noise, 6.4.6 Energy economy and heat retention

Not relevant to this component.

6.4.7 Aspects of serviceability and identification

The classification of the gasket from ISO/DIS 3934 shall be stated.

6.5 COMPONENT / FIXINGS

6.5.1 Mechanical resistance and stability

When tested or assessed in accordance with 5.5.1 the tensile and shear capacity shall be determined and included in the overall assessment of performance.

6.5.2 Behaviour in fire,

Not relevant to this component

6.5.3 Hygiene, health and the environment

6.5.3.1 Release of dangerous substances

See 6.1.3.1

6.5.4 Safety in use

See 6.5.1

6.5.5 Protection against noise, 6.5.6 Energy economy and heat retention

Not relevant to this component.

6.5.7 Aspects of durability, serviceability and identification.

6.5.7.1 Metallic Fasteners – Corrosion Resistance

Unless they are made from material that is inherently corrosion resistant, metallic fasteners must be suitably protected.
After the test in 5.5.7.1 protected metallic parts shall not exhibit more than 15% surface corrosion (rust formation) or corrosion formation recognisable beneath the corrosion protection. Fasteners meeting this

criterion may be used where the conditions in the roof present only a slight risk of corrosion due to condensation. Fasteners for use without restriction should be made from inherently corrosion resistant material.

7. ASSUMPTIONS AND RECOMMENDATIONS UNDER WHICH THE FITNESS FOR USE OF THE PRODUCTS IS ASSESSED

This chapter sets out the assumptions recommendations for design, installation and execution, packaging, transport and storage, use, maintenance and repair under which the assessment of the fitness for use according to the ETAG can be made (only when necessary and in so far as they have a bearing on the assessment or on the products).

7.1 DESIGN OF WORKS

The design of a roof incorporating a Self-Supporting Translucent Roof Kit, in many important respects, will be specific to the works on which it is to be used.

This includes the overall structural performance of the roof, the hygrothermal behaviour and basic requirements on the rigid supports of the assembled roof. The following is a brief list of aspects it is assumed will be taken into account when designing the roof; the list is not exhaustive:

- Dead and imposed loads, including snow
- Design wind pressure
- Structural strength and deflection limits
- Attachment of the supports to the structural framing
- The assessment of condensation risk and the provision of vapour control layers and thermal insulation
- Solar heat gain
- Sound insulation
- Fire protection
- Roof attachments, fixtures and penetrations
- Falls and requirements for drainage
- Means of access for inspection and maintenance

The ETA will indicate the conditions for design of the particular roof kit into the works. It is for the designer to ensure that the roof as installed in the works will provide the required performance on the basis of the information given in the ETA such as the following:

- Permissible deflections under various loads, including the combination of these, as necessary (See Annex J), e.g. wind load, uniform and half snow loading
- Permissible deflections of the adjacent structural parts
- Where and how the kit is fixed to the supports
- Availability of special fixings for seismic conditions. In case of dynamic actions, such as those occurring in case of an earthquake, it is assumed the designer will take account of the possible contribution of the roof kit in accordance with national or local regulations.

7.2 PACKAGING, TRANSPORT AND STORAGE

The roof kit shall be protected from damage and excessive exposure to direct sunlight and moisture during transportation and storage, also in case of short-term storage, as there is a risk of heat build-up and consequent risk of distortion etc. Any damaged component shall not be used.

The roof kits shall be handled and stored with care and be protected from accidental damage.

7.3 EXECUTION OF WORKS

Any further conditions for design and execution of the system into the works shall be taken from the manufacturer's Installation Guide. The quality and sufficiency of this Installation Guide shall be assessed, in particular concerning the aspects indicated in chapter 9.1 of this Guideline, Information on the design and on the following check list, which is not exhaustive:

- Provisions for installing opening devices
- Type of fasteners, e.g. steel type, dimensions
- Spacing between fasteners
- Tolerances
- Provision for thermal expansion
- Order of installation of the various components
- Provisions for installation of mechanical ventilation equipment
- Compatibility of materials as a result of installation, eg contact between polycarbonate and mortar

It shall be stated in the ETA that the Installation Guide forms part of the ETA. The ETA holder is responsible for delivering the Installation Guide to the roofing contractor. The ETA may take over the essential parts of the Guide.

The execution of the works must be practicable under normal site conditions and is assumed to be performed by trained installers.

7.4 MAINTENANCE AND REPAIR

The assessment of the fitness for use is based on the assumption that normal maintenance of the assembled roof is performed.

This maintenance shall include:

- Cleaning, as necessary, carried out with a soft brush and normal cleaning product compatible with the roof kit components followed by a rinsing off with water. It is a normal assumption that the assembled roof shall not be cleaned with products containing solvents or abrasive or grinding agents, nor shall the surface of the roof be treated with wax.

- Early repair of damaged areas or parts eg translucent sheets

When replacing weather seals and other components the materials shall be approved by the manufacturer and covered by the ETA.

SECTION THREE: ATTESTATION AND EVALUATION OF CONFORMITY (AC)

8 ATTESTATION AND EVALUATION OF CONFORMITY

8.1 EC DECISION

The systems of attestation of conformity specified by the Commission Decision 98/600/EC, as amended, and specified in mandate CONSTRUCT 98/267, Annex 3 as follows:

System 1 for roof kits

- with Euroclasses A1*, A2*,B* or C* concerning reaction to fire

* 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)

Regarding products falling under System 1, for initial type testing of the product [see Annex III.1.a) of the CPD] the task for the Approved body will be limited to the following characteristic;

Euroclasses characteristics for reaction to fire

For products under system 1, regarding continuous surveillance, assessment and approval of the factory production control [see Annex iii.1.g) of the CPD] and for the initial inspection of the factory and of the factory production control [see Annex iii.1.f) of the CPD], parameters related to the following characteristics shall be of interest to the Approved body:

Euroclasses characteristics for reaction to fire

System 3 for roof kits

- for general use in roofs and roof finishes
- with Euroclasses A1**, A2**, B**, C**, D, E, concerning reaction to fire

** products/materials not covered by footnote(*)

- for uses subject to external fire performance regulations and requiring testing

Regarding products falling under System 3 for general use in roofs and roof finishes, the tasks for the Approved body, for initial type testing of the product [see Annex III.1.a) of the CPD] shall be limited to the following (as relevant):

Resistance to fire
Watertightness
Racking resistance
Mechanical resistance
Impact resistance
Shatter properties / safe breakability
Resistance to live horizontal loads
Release of dangerous substances

For products falling under System 3 in relation to reaction to fire, for initial type testing of the product [see Annex iii.1.a) of the CPD] the task for the Approved body shall be limited to the following characteristic:

Euroclasses characteristics for reaction to fire

For products falling under System 3 in relation to external fire performance (ie those products requiring testing), for initial type testing of the product [see Annex III.1.a) of the CPD] the task for the Approved body shall be limited to the following characteristics, where applicable:

External Fire Performance

See 8.2.2.1 regarding initial type tests in relation to ETA's.

System 4 for roof kits

– with Euroclasses (A1 to E)***, F concerning reaction to fire

***Products/materials that do not require to be tested for reaction to fire (e.g. Products/materials of class A1 according to Commission Decision 2000/605/EC, as amended).

.

The systems are described in Council Directive (89 /106/EEC) Annex III, 2(i) without audit testing of samples, 2(ii) Second possibility and 2(ii) Third possibility, respectively, and are detailed as follows:

System 1

(a) **Tasks for the manufacturer**

– factory production control

– further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan.

(b) **Tasks for the approved body**

– initial type-testing of the product

– initial inspection of the factory and of factory production control

– continuous surveillance, assessment and approval of factory production control

– certification of conformity of the product

System 3

(a) **Tasks for the manufacturer**

– factory production control

(b) **Tasks for the approved body**

– initial type testing of the product by an approved laboratory

System 4

(a) **Tasks for the manufacturer**

– factory production control

– initial type testing of the product.

8.2 RESPONSIBILITIES

8.2.1 Tasks for the Manufacturer

8.2.1.1 Factory Production Control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures. This production control system shall ensure that the product is in conformity with the ETA.
Manufacturers having an FPC system that complies with EN ISO 9001 **and** which addresses the requirements of an ETA are recognised as satisfying the FPC requirements of the Directive.

8.2.1.2 Testing of samples taken at the factory (System 1)

Both large and small companies produce these products and there is a wide variation in the materials used. Therefore, a precise test plan can only be set up on a case by case basis.

In general, it is not necessary to conduct tests on complete roof kits. Indirect methods will normally be sufficient, e.g. control of raw materials, manufacturing processes and properties of components.
Where the parameters given in 5.3.1.3 are used for production control, it is normally sufficient to prove, using one test specimen taken out of a certain volume of production (three times a day is recommended as a minimum) that the given requirements are fulfilled.

8.2.1.3 Declaration of Conformity (System 3 and System 4)

When all the criteria of the Conformity Attestation are satisfied the manufacturer shall make a Declaration of Conformity.

8.2.2 Tasks for the manufacturer or the approved body

8.2.2.1 Initial Type Testing

Approval tests will have been conducted by the approval body or under its responsibility (which may include a proportion conducted by a laboratory or by the manufacturer, witnessed by the approval body) in accordance with Chapter 5 of this ETAG. The approval body will have assessed the results of these tests in accordance with Chapter 6 of this ETAG, as part of the ETA issuing procedure.

These tests shall be used for the purposes of Initial Type Testing. In this respect approval bodies shall be able to have open arrangements with relevant approved bodies to avoid duplication, respecting each others responsibilities.

System 1: the approved body shall validate this work for Certificate of Conformity purposes.

System 3: an approved laboratory shall validate this work for Declaration of Conformity purposes by the manufacturer.

System 4: this work should be taken over by the manufacturer for Declaration of Conformity purposes.

8.2.3 Tasks for the approved body (System 1)

8.2.3.1 Assessment of the factory production control system - initial inspection and continuous surveillance

Assessment of the factory production control system is the responsibility of the approved body.

An assessment must be carried out of each production unit to demonstrate that the factory production control is in conformity with the ETA and any subsidiary information. This assessment shall be based on an initial inspection of the factory.

Subsequently continuous surveillance of factory production control is necessary to ensure continuing conformity with the ETA.

It is recommended that surveillance inspections be conducted at least twice per year.

8.2.3.2 Certification of Conformity

The approved body shall issue Certification of Conformity of the product.

8.3 DOCUMENTATION

In order to help the approved body make an evaluation of conformity the approval body issuing the ETA shall supply the information detailed below. This information together with the requirements given in EC Guidance Paper B will:

System 1: generally form the basis on which the factory production control (FPC) is assessed by the approved body

System 3:
and
System 4: generally form the basis of FPC.

This information shall initially be prepared or collected by the approval body and shall be agreed with the manufacturer. The following gives guidance on the type of information required:

(1) The ETA

See section 9 of this Guideline.

The nature of any additional (confidential) information shall be declared in the ETA.

(2) Basic manufacturing process

The basic manufacturing process shall be described in sufficient detail to support the proposed FPC methods.

Components for roof kits are normally manufactured using conventional techniques. Any critical process or treatment of the components affecting performance shall be highlighted.

(3) Product and materials specifications

These may include:
detailed drawings (including manufacturing tolerances)
incoming (raw) materials specifications and declarations
references to European and/or international standards or appropriate specifications
manufacturer’s data sheets.

(4) Test plan

The manufacturer and the approval body issuing the ETA shall agree an FPC test plan.

An agreed FPC test plan is necessary as current standards relating to quality management systems (Guidance Paper B, EN 29002, etc), do not ensure that the product specification remains unchanged and they cannot address the technical validity of the type or frequency of checks/tests.

The validity of the type and frequency of checks/tests conducted during production and on the final product shall be considered, together with the possible need for checks on any bought-in components. This will include the checks conducted during manufacture on properties that cannot be inspected at a later stage and for checks on the final product.

For the translucent sheets, Table 5.2 in Chapter 5 gives properties that should be controlled but, for the purposes of FPC, the manufacturer may adopt an alternative test method provided it gives sufficient assurance of the property controlled. In addition it may be necessary to test the resistance of materials, particularly PMMA, to environmental stress cracking. In such cases the method given in EN ISO 12017 may be used.

Where materials/components are not manufactured and tested by the kit supplier in accordance with agreed methods then, where appropriate, they must be subject to suitable checks/tests by the manufacturer before acceptance.

(5) Prescribed test plan (**System 1**)

The manufacturer and the approval body issuing the ETA shall agree a prescribed test plan.

The characteristic to be addressed as described in the mandate is Reaction to fire. This will be controlled at least twice per year by analysis/measurement of the relevant characteristics for the components of the kit from the following list:

composition
dimensions
physical properties
mechanical properties

8.4 CE MARKING AND INFORMATION

The ETA shall indicate the information to accompany the CE marking and the placement of CE marking and the accompanying information (the kit/components itself/themselves, an attached label, the packaging, or the accompanying commercial documents).

According to the CE Guidance Paper D on CE marking, the required information to accompany the symbol "CE" is:

- identification number of the notified body (**System 1**)
- name or identifying mark of the producer
- last two digits of the year in which the marking was affixed
- number of the EC certificate of conformity (**System 1**)
- number of the ETA (valid as indications to identify the characteristics of the roof kit and the characteristics where the 'no performance determined' approach is used, including reference to the range of ambient temperature suitable for the products assessed).

SECTION FOUR: ETA CONTENT

9. THE ETA CONTENT

9.1 ETA CONTENT

The format of the ETA shall be in accordance with the Commission Decision 97/571/EC dated 22/7/97 - EC Official Journal L236 of 27/08/97.

For a self-supporting translucent roof kit the following information shall be provided as a minimum:

9.1.1 Performance

Performance characteristics in relation to:

- Mechanical behaviour in terms of resistance to uplift, downward load and, where relevant, eccentric loads.

- Reaction to fire and external fire performance for the kit and for the individual components.

- Hygiene, health and the environment in terms of:

Release (content) of dangerous substances.

In section II.2 “Characteristics of products and methods of verification” the ETA shall include the following note:
“In addition to the specific clauses relating to dangerous substances contained in this European Technical Approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.”

Watertightness /*Condensation.
Resistance to wind driven rain and snow

- Safety in use in terms of:

Impact resistance – comment to be made on any penetration of the outer skin of multi-skinned sheets in the hard body impact test.
Resistance to live horizontal loads
Geometry - height of handrails, spacing of bars in balustrades or other critical dimensions
Safe opening

- Protection against noise in terms of:

Sound insulation

- Energy economy and heat retention in terms of:

Thermal resistance
*Condensation
Air permeability
Solar transmission
Durability aspects

*Relevant to ER3 and ER6

No performance determined options are possible for some of these characteristics (see Table 6.1).

9.1.2 Specification

The ETA shall show a horizontal and vertical cross sections of a typical assembly, at supports, at abutments and shall contain, as a minimum, the following details of the kit.

9.1.2.1 Dimensions

The following dimensions shall be given together with tolerances where relevant.

- for the translucent sheets:

thickness, cross-section details, maximum overall dimensions with tolerances including flatness and maximum permissible overall sizes, exposure category in relation to solar radiation.

- for the additional bearing profiles:

cross section details, external dimensions, with tolerances on straightness of members and maximum permissible spans.

- for all pre-formed sealing profiles:
  cross section details and major dimensions
- for the supplementary components:
  details shall be given of all supplementary components such as rainwater goods, safety anchorages, and hardware used on opening parts

9.1.2.2 Components and accessories

The following general details of the major component and accessory specifications shall be given in the ETA.

- identification of the material used
- the manufacturer and type designation
- the characteristics of any surface coating
- the availability and implications, where relevant, of tinted translucent sheets

The ETA shall also contain any details of the installation which the approval body considers worthy of note, as described in Chapter 7 of this Guideline and details of the maximum acceptable deflection in the supporting structure and details of any particular risks identified during the assessment. The latter would include such aspects as the possibility of environmental stress cracking of translucent materials in certain environments, the need to avoid contact with other materials in an installed kit or the risk of internal condensation in structured translucent sheets.

9.2 ADDITIONAL INFORMATION

It shall be stated that the manufacturer’s installation guide forms part of the ETA, see 7.1

Similarly, it shall be stated in the ETA whether or not any additional information (possibly confidential) shall be supplied to the Approved Body for the evaluation of the attestation of conformity, see clause 8.3 of this Guideline.

Where a kit has been assessed as being suitable for use under sustained low temperature conditions, this shall be stated.

ANNEX A

COMMON TERMINOLOGY(definitions, clarifications, abbreviations)

1. WORKS AND PRODUCTS

1.1 Construction works (and parts of works) (often simply referred to as "works") (ID 1.3.1)
Everything that is constructed or results from construction operations and is fixed to the ground.
(This covers both building and civil engineering works, and both structural and non structural elements).

1.2. Construction products (often simply referred to as "products") (ID 1.3.2)
Products which are produced for incorporation in a permanent manner in the works and placed as such on the market.
(The term includes materials, elements and components of prefabricated systems or installations)

1.3. Incorporation (of products in works) (ID 1.3.2)
Incorporation of a product in a permanent manner in the works means that:
- its removal reduces the performance capabilities of the works, and
- that the dismantling or the replacement of the product are operations which involve construction activities.

1.4. Intended use (ID 1.3.4)
Role(s) that the product is intended to play in the fulfillment of the essential requirements.
(N.B. This definition covers only the intended use as far as relevant for the CPD)

1.5. Execution (ETAG-format)
Used in this document to cover all types of incorporation techniques such as installation, assembling, incorporation, etc.

1.6. System (EOTA/TB guidance)
Part of the works realised by
- particular combination of a set of defined products, and
- particular design methods for the system, and/or
- particular execution procedures.

2. PERFORMANCES

2.1. Fitness for intended use (of products) (CPD 2.1)
Means that the products have such characteristics that the works in which they are intended to be incorporated, assembled, applied or installed, can, if properly designed and built, satisfy the essential requirements.
(N.B. This definition covers only the intended fitness for intended use as far as relevant for the CPD)

2.2. Serviceability (of works)
Ability of the works to fulfill their intended use and in particular the essential requirements relevant for this use.

The products must be suitable for construction works which (as a whole and in their separate parts) are fit for their intended use, subject to normal maintenance, be satisfied for an economically reasonable working life. The requirements generally concern actions which are foreseeable (CPD Annex I, Preamble).

2.3. Essential requirements (for works): requirements applicable to works, which may influence the technical characteristics of a product, and are set out in terms of objectives in the CPD, Annex I (CPD, art. 3.1).

2.4. Performance (of works, parts of works or products) (ID 1.3.7)
The quantitative expression (value, grade, class or level) of the behaviour of the works, parts of works or of the products, for an action to which it is subject or which it generates under the intended service conditions (works or parts of works) or intended use conditions (products).

As far as practicable the characteristics of products, or groups of products, should be described in measurable performance terms in the technical specifications and guidelines for ETA. Methods of calculation, measurement, testing (where possible), evaluation of site experience and verification, together with compliance criteria shall be given either in the relevant technical specifications or in references called up in such specifications.

2.5. Actions (on works or parts of the works) (ID 1.3.6)
Service conditions of the works which may affect the compliance of the works with the essential requirements of the Directive and which are brought about by agents (mechanical, chemical, biological, thermal or electro-magnetic) acting on the works or parts of the works.
Interactions between various products within a work are considered as "actions".

2.6. Classes or levels (for essential requirements and for related product performances) (ID 1.2.1)
A classification of product performance(s) expressed as a range of requirement levels of the works, determined in the ID's or according to the procedure provided for in art. 20.2a of the CPD.

3. ETAG - FORMAT

3.1. Requirements (for works) (ETAG-format 4.)
Expression and application, in more detail and in terms applicable to the scope of the guideline, of the relevant requirements of the CPD (given concrete form in the ID's and further specified in the mandate, for works or parts of the works, taking into account the durability and serviceability of the works.

3.2. Methods of verification (for products) (ETAG-format 5.)
Verification methods used to determine the performance of the products in relation to the requirements for the works (calculations, tests, engineering knowledge, evaluation of site experience, etc.).

This verification methods are related only to the assessment of, and for judging the fitness for use. Verification methods for particular designs of works are called here "project testing", for identification of products are called "identification testing", for surveillance of execution or executed works are called "surveillance testing", and for attestation of conformity are called "AC-testing".

3.3. Specifications (for products) (ETAG-format 6.)
Transposition of the requirements into precise and measurable (as far as possible and proportional to the importance of the risk) or qualitative terms, related to the products and their intended use. *The satisfaction of the specifications is deemed to satisfy the fitness for use of the products concerned.*

Specifications may also be formulated with regard to the verification of particular designs, for identification of products, for surveillance of execution or executed works and for attestation of conformity, when relevant.

4. WORKING LIFE

4.1. Working life (of works or parts of the works) (ID 1.3.5(1)
The period of time during which the performance will be maintained at a level compatible with the fulfilment of the essential requirements.

4.2. Working life (of products)
Period of time during which the performances of the product are maintained - under the corresponding service conditions - at a level compatible with the intended use conditions.

4.3. Economically reasonable working life: (ID 1.3.5(2)
Working life which takes into account all relevant aspects, such as costs of design, construction and use, costs arising from hindrance of use, risks and consequences of failure of the works during its working life and cost of insurance covering these risks, planned partial renewal, costs of inspections, maintenance, care and repair, costs of operation and administration, of disposal and environmental aspects.

4.4. Maintenance (of works) (ID 1.3.3(1)

A set of preventive and other measures which are applied to the works in order to enable the works to fulfil all its functions during its working life. These measures include cleaning, servicing, repainting, repairing, replacing parts of the works where needed, etc.

4.5. Normal maintenance (of works) (ID 1.3.3(2)
Maintenance, normally including inspections, which occurs at a time when the cost of the intervention which has to be made is not disproportionate to the value of the part of the work concerned, consequential costs (e.g. exploitation) being taken into account.

4.6. Durability (of products)
Ability of the product to contribute to the working life of the work by maintaining its performances, under the corresponding service conditions, at a level compatible with the fulfilment of the essential requirements by the works.

5. CONFORMITY

5.1. Attestation of conformity (of products)
Provisions and procedures as laid down in the CPD and fixed according to the directive, aiming to ensure that, with acceptable probability, the specified performance of the product is achieved by the ongoing production.

5.2. Identification (of a product)
Product characteristics and methods for their verification, allowing to compare a given product with the one that is described in the technical specification.

6. APPROVAL AND APPROVED BODIES

6.1. Approval Body
Body notified in accordance with Article 10 of the CPD, by an EU Member State or by an EFTA State (contracting party to the EEA Agreement), to issue European Technical Approvals in (a) specific construction product area(s). All such bodies are required to be members of the European Organisation for Technical Approvals (EOTA), set up in accordance with Annex II.2 of the CPD.

6.2. Approved Body(*)
Body nominated in accordance with Article 18 of the CPD, by an EU Member State or by an EFTA State (contracting party to the EEA Agreement) , to perform specific tasks in the framework of the Attestation of Conformity decision for specific construction products (certification, inspection or testing). All such bodies are automatically members of the Group of Notified Bodies.

(*) also known as Notified Body

ABBREVIATIONS

Concerning the Construction Products Directive:

AC: Attestation of Conformity
CEC: Commission of the European Communities
CEN: Comité Européen de Normalisation / European Committee for Standardization
CPD: Construction Products Directive
EC: European Communities
EFTA: European Free Trade Association
EN: European standard
FPC: Factory production control
ID: Interpretative documents of the CPD
ISO: International Standardisation Organisation
SCC: Standing Committee for Construction of the EC

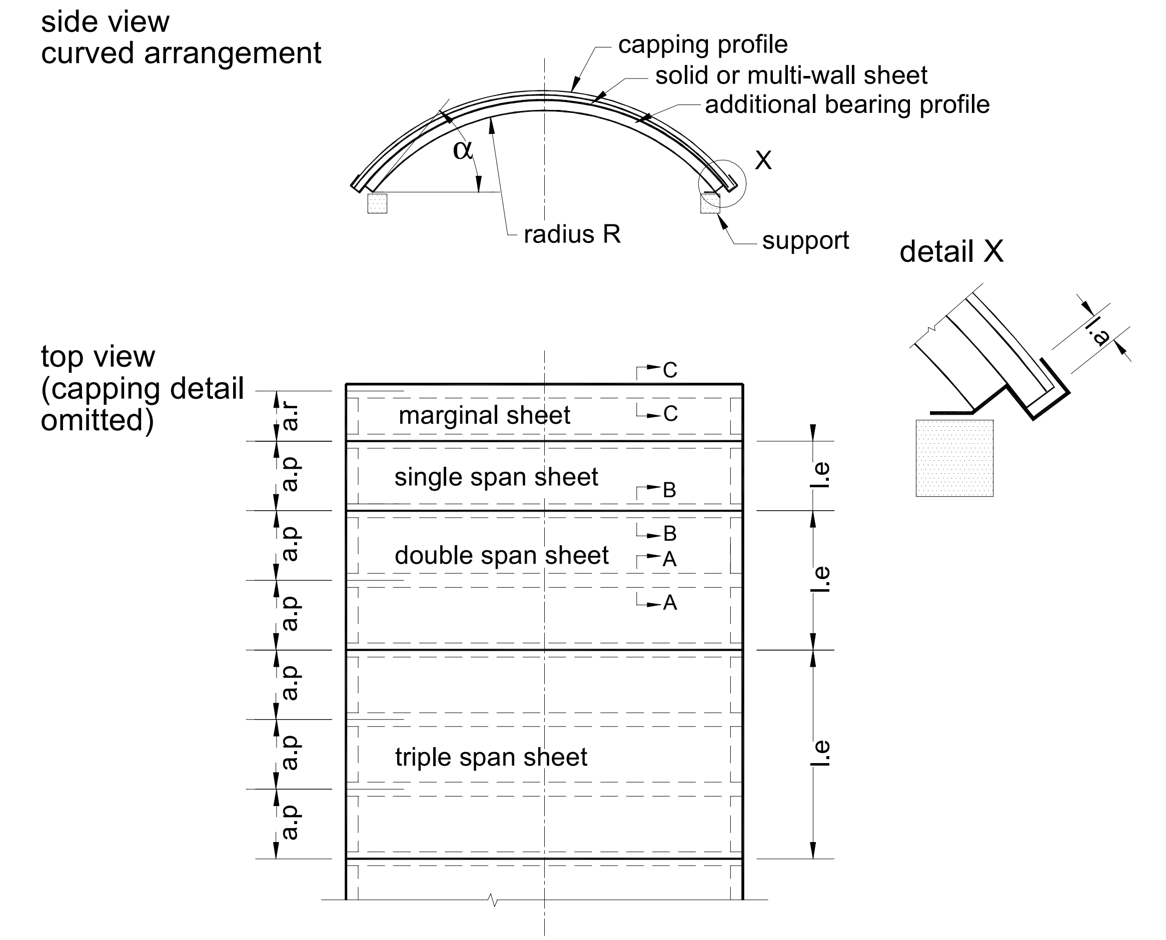
Concerning approval:

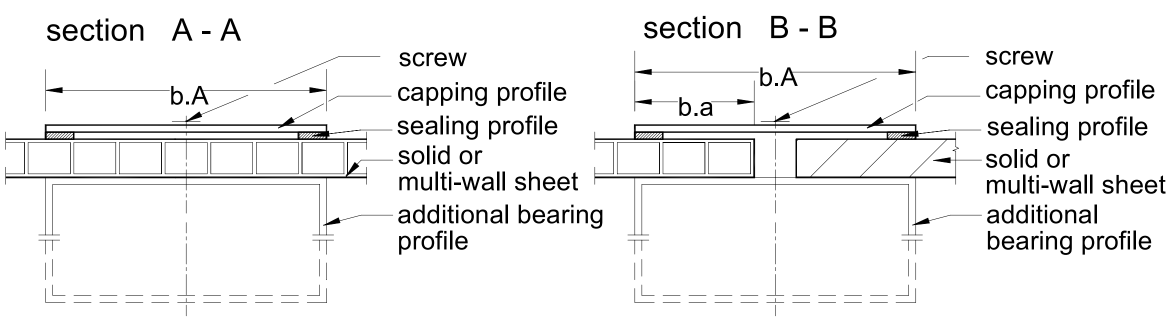
EOTA: European Organisation for Technical Approvals
ETA: European Technical Approval
ETAG: European Technical Approval Guideline
TB: EOTA-Technical Board
UEAtc: Union Européenne pour l'Agrément technique dans la construction / European Union of Agrément

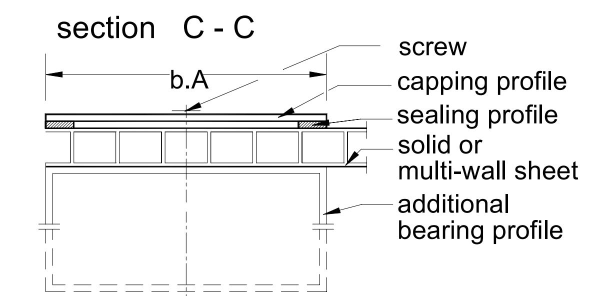
General:
TC: Technical committee
WG: Working group

Annex B - Examples of roof kit types

Contents







l.e : sheet width
l.a : bearing length of the sheet
a.p : distance between the bearing profiles
a.r : distance between the bearing profiles of marginal sheets
b.A : width of the bearing profiles
b.a : supported width of the sheet

Where drilled holes are to be avoided, e. g. in PMMA - sheets, the covering profiles in curved systems can be alternativly fixed at the end support (similar to a tie member).

Fig B1.2.1 Example of curved roof kits with additional bearing profiles single, double and triple span systems

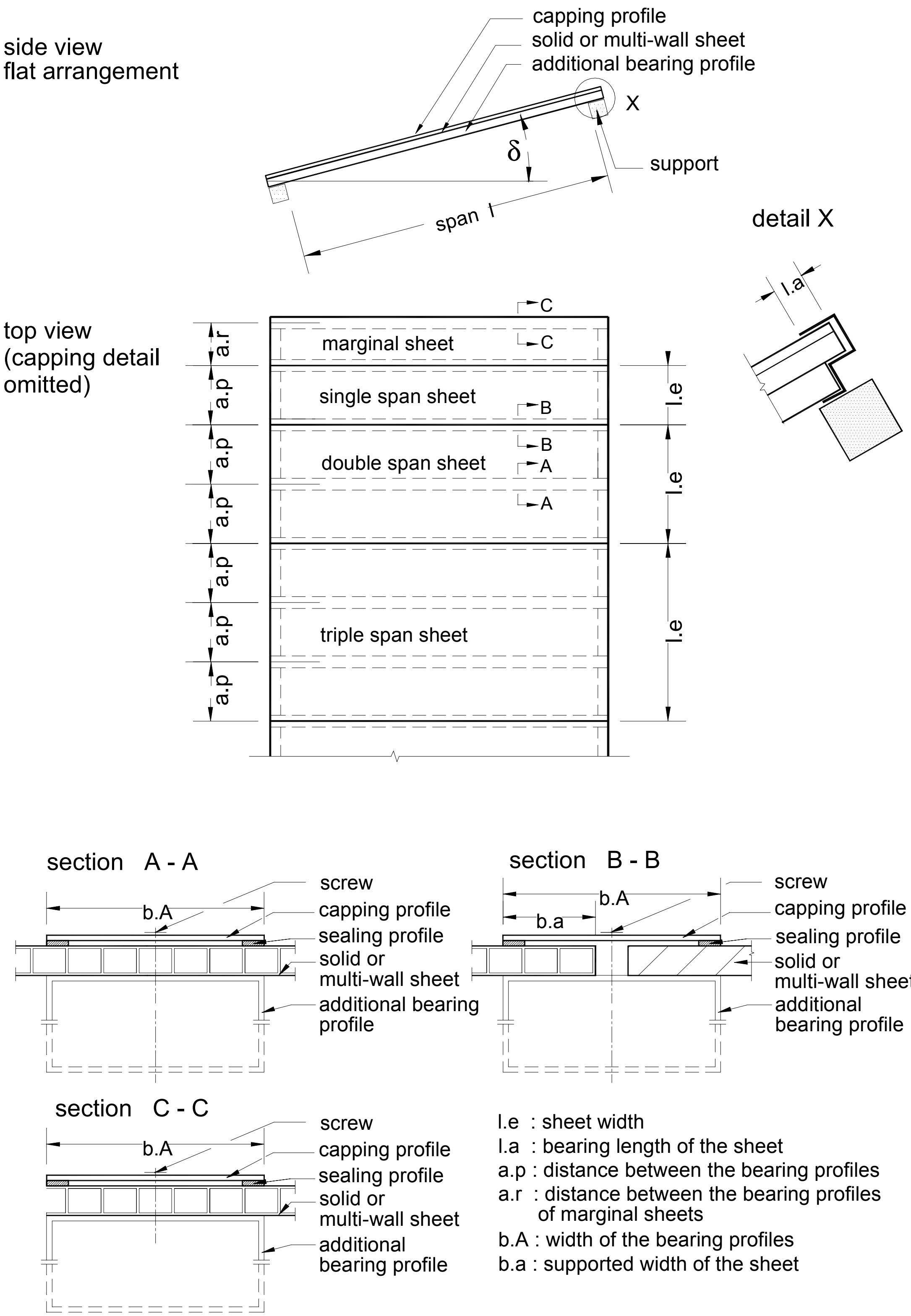
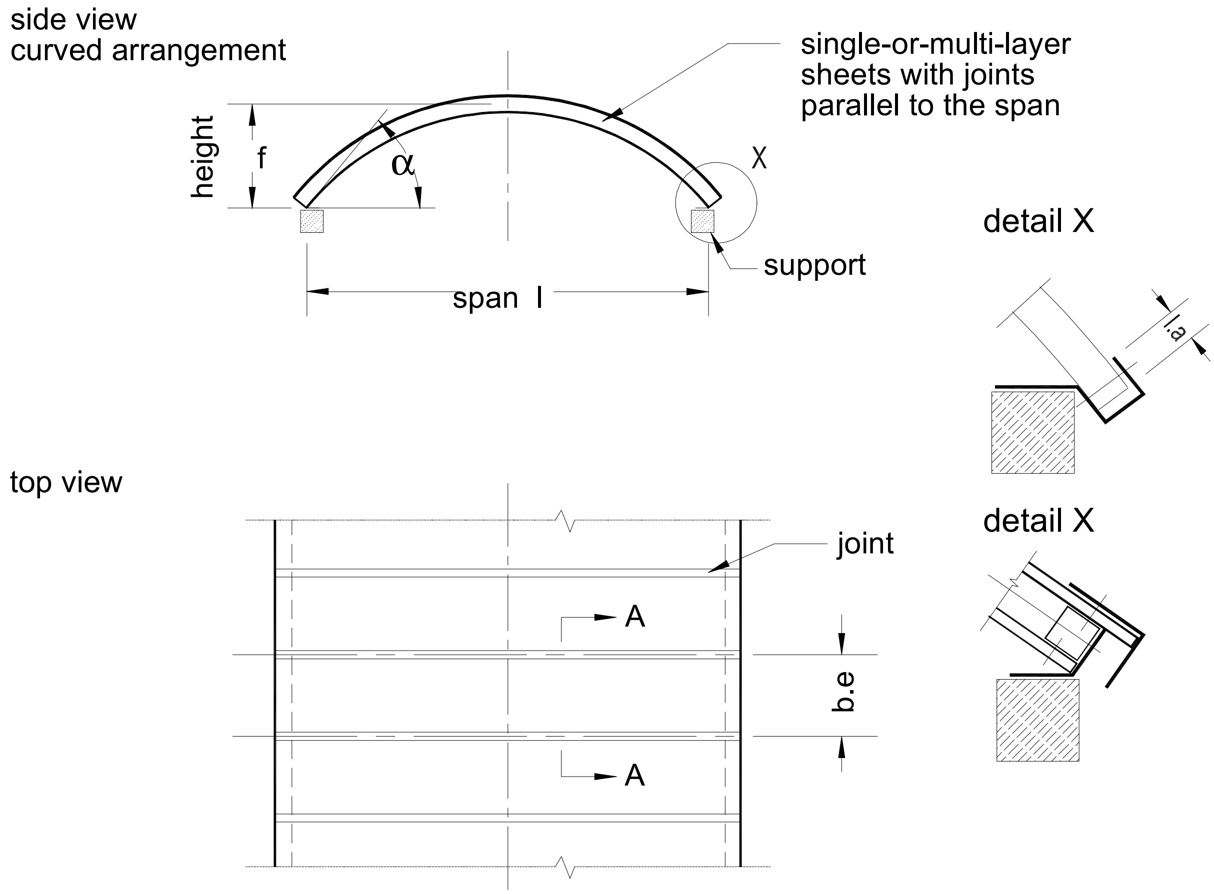


Fig B1.2.2 Example of flat roof kits with additional bearing profiles single, double and triple span systems



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

section A-A

examples of different cross sections and joints

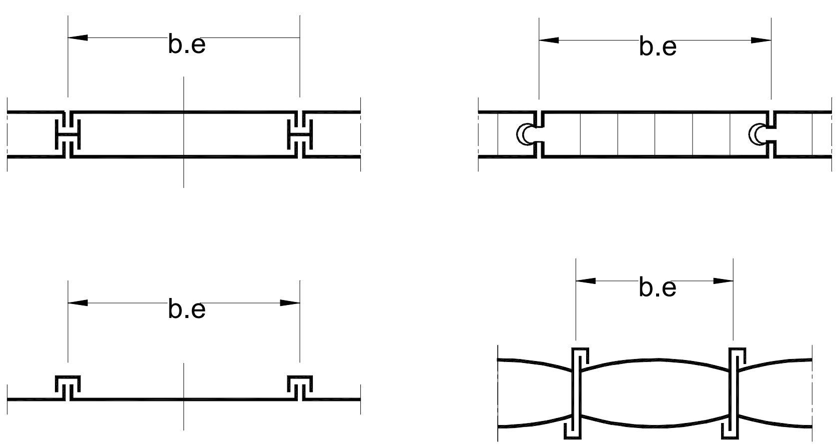


Fig B1.3.1 Examples of curved roof kits without additional bearing profiles- single span systems

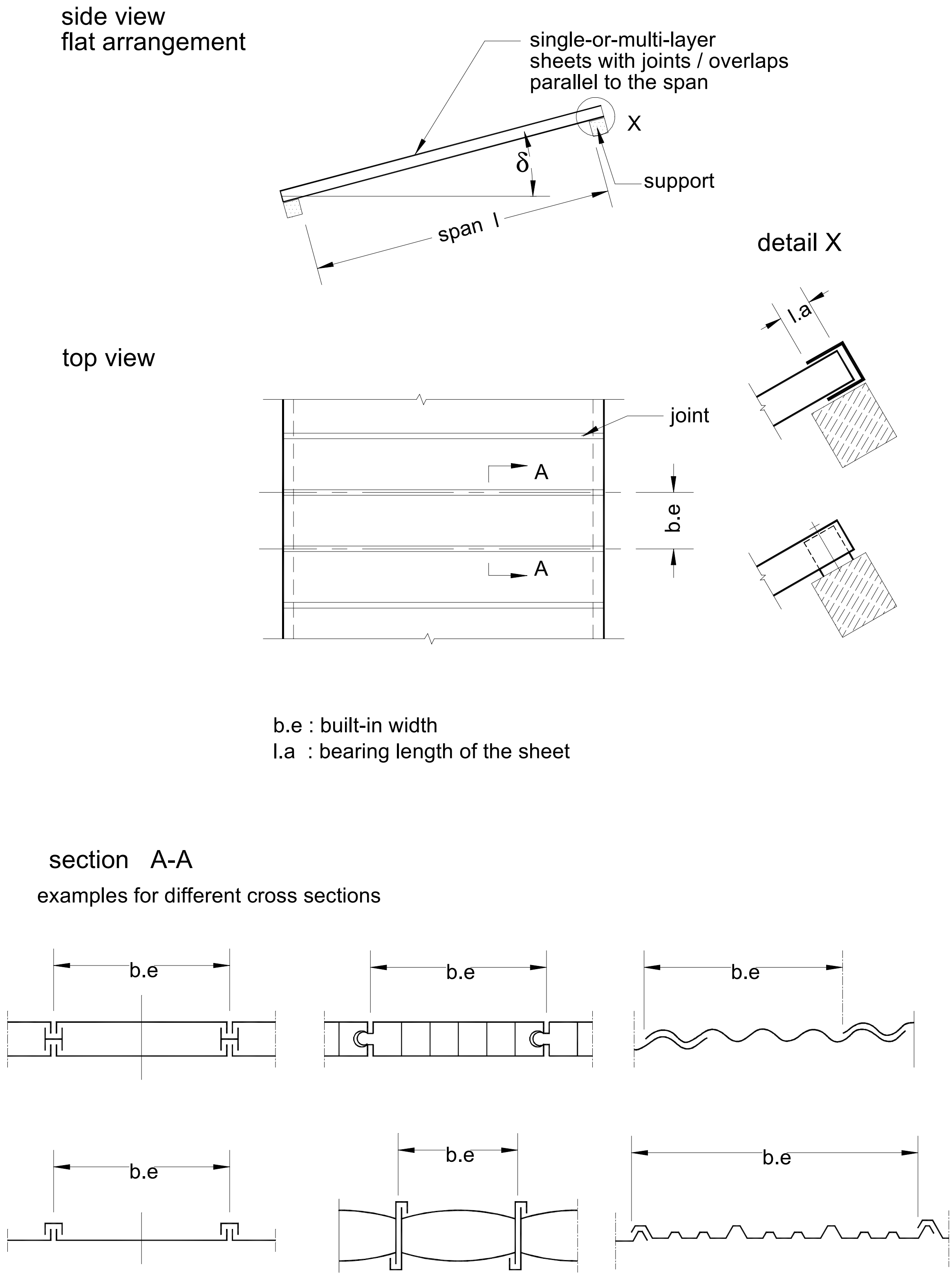


Fig B1.3.2 Examples of flat roof kits without additional bearing profiles single span systems

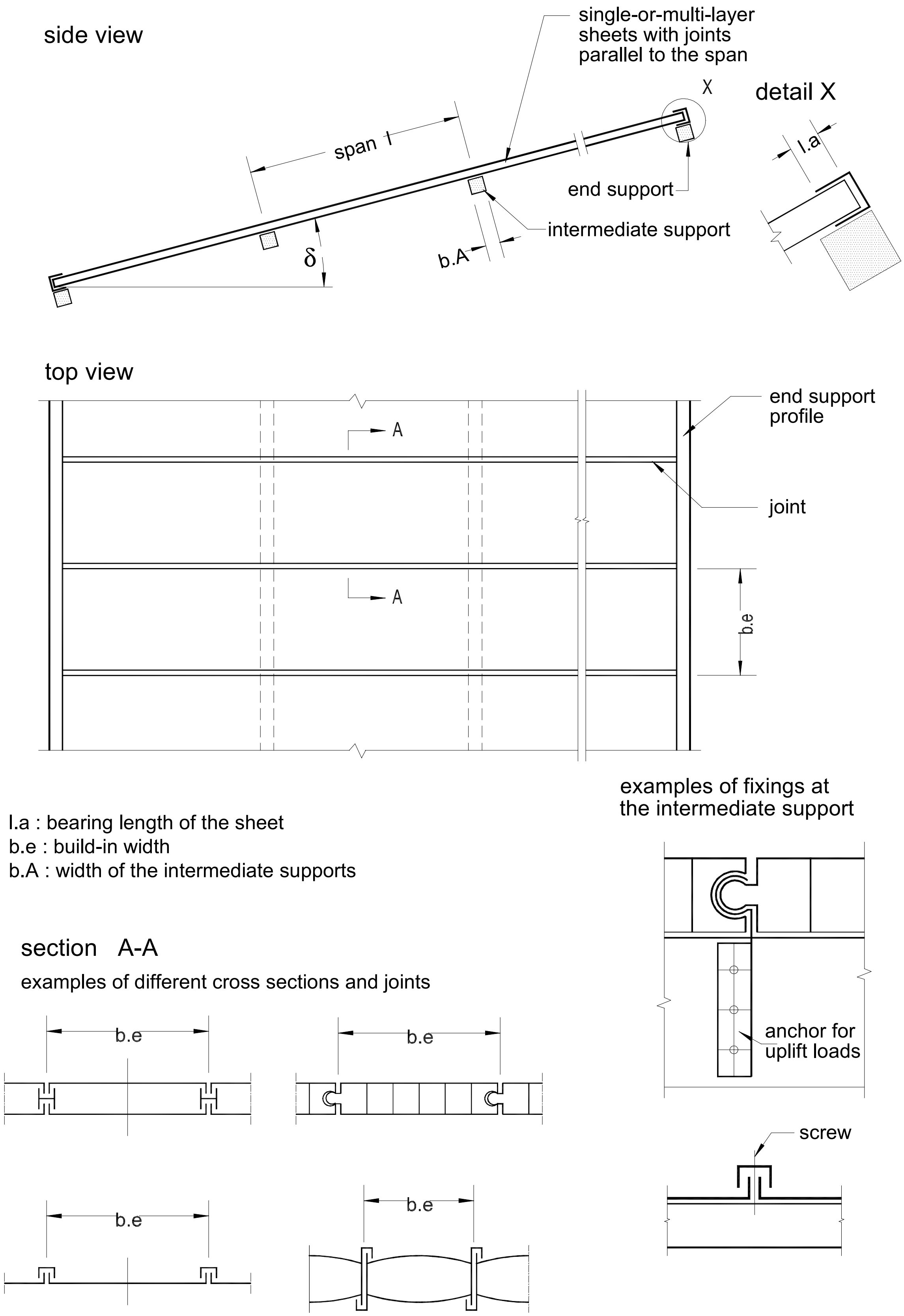


Fig B1.4 Examples of flat roof kits with single or multi-layer-sheets, joints parallel and supporting profiles perpendicular to the span - multi span systems

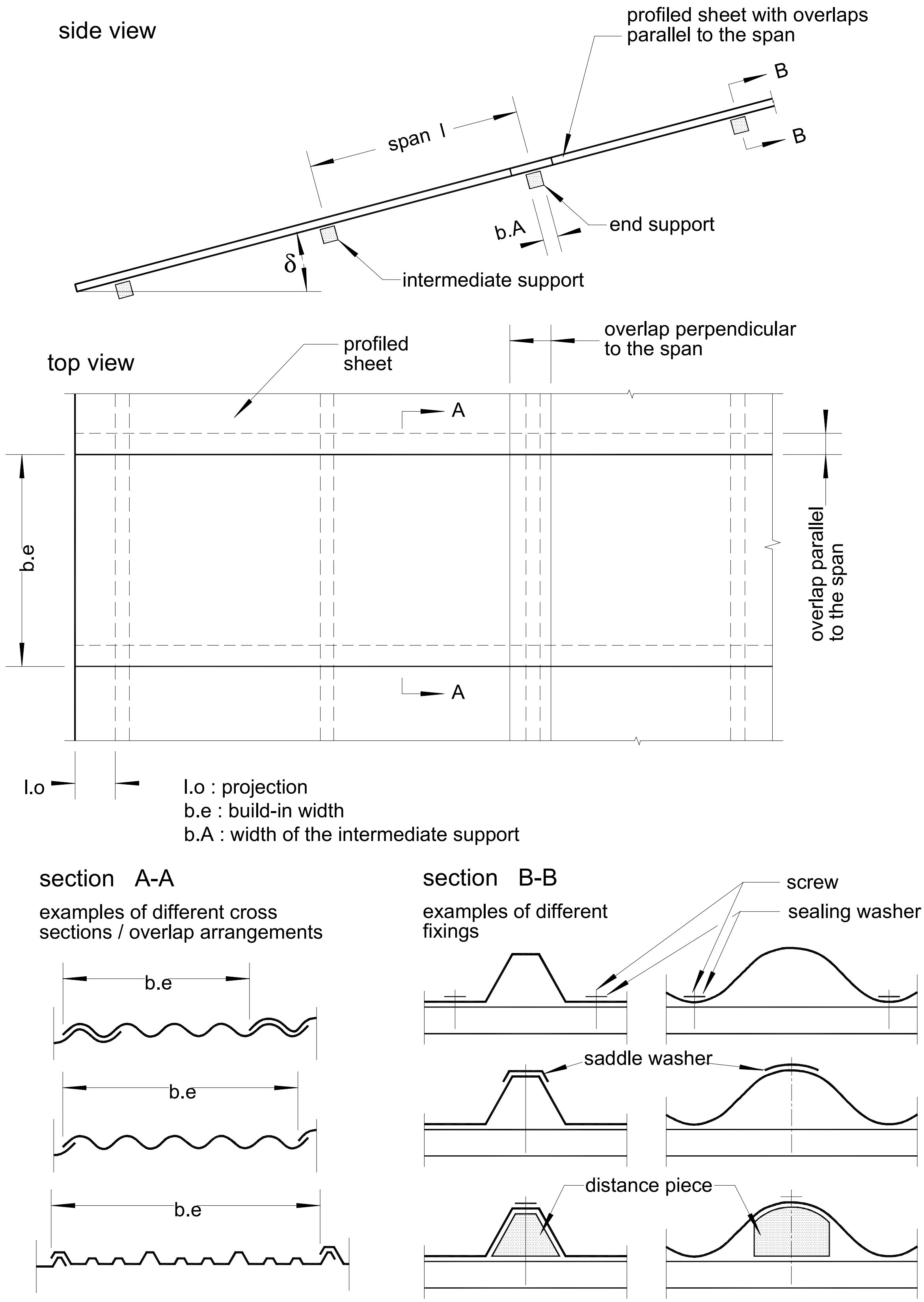


Fig B1.5 Examples of flat roof kits with profiled sheets and supporting profiles perpendicular to the span- multi span systems

Annex C - Racking Resistance

C.1 **Principle**

The purpose of the test is to determine the resistance of one repeatable translucent unit to applied racking (horizontal) loads.

C1.2 **Apparatus**

The apparatus shall comprise a robust reaction frame and a means of applying a uniform in-plane load. Hydraulic cylinders and a spreader bar would be suitable. Unless vertical load (dead load and snow load) is taken into account by calculation, it is also necessary to provide for a vertical load, to simulate these actions during the test. A suitable means of loading would be sandbags. See Fig C2.

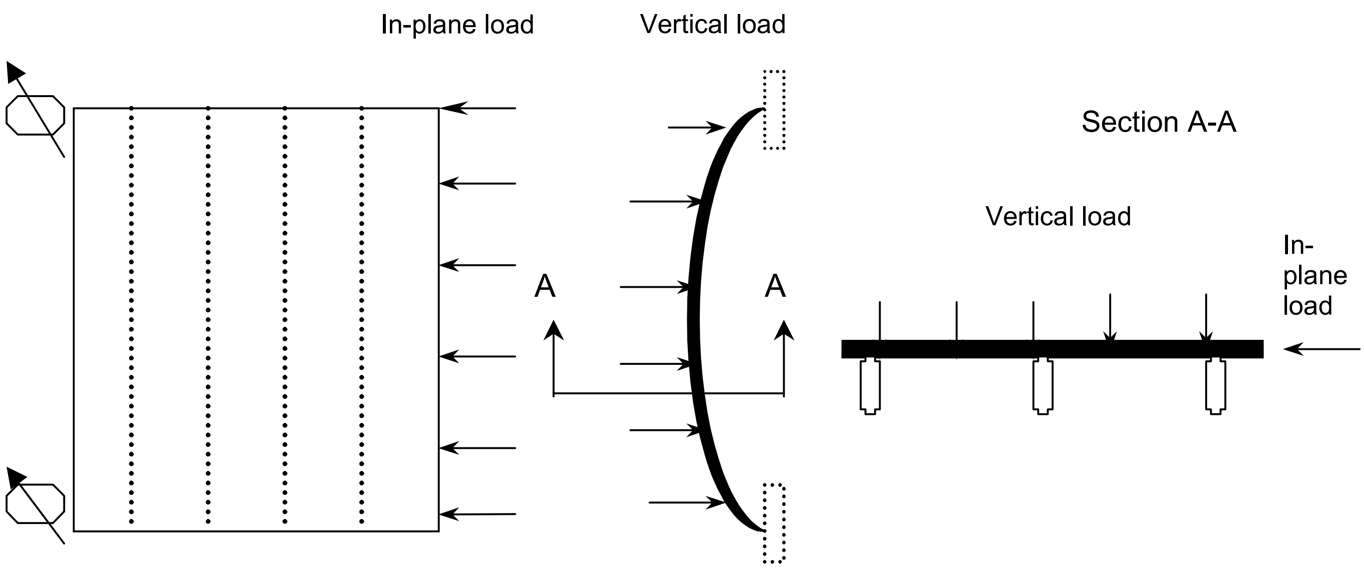


Fig C.2:

Test arrangement (Schematic)

The test specimen shall comprise one repeatable unit. Where this unit incorporates translucent material fixed in such a way that horizontal load transfer is possible (see 5.1.1.2) the test specimen may include more than one translucent section separated by additional bearing profiles. Suitable means shall be provided to measure the horizontal load and deflection .

Test procedure

The vertical load, increased by the partial safety factor for service loads, is applied to the specimen. The in-plane load is then applied and the deformation measured in steps until failure occurs.

Annex D - Watertightness test under static pressure

D.1 Principle

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

D.2 Apparatus

A chamber 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.

A means of reducing the air pressure within the test chamber to create a differential positive pressure to the sample with respect to its exterior face.

A means of measuring the applied differential pressure with an accuracy ± 1%.

An adjustable device for spraying water at 2 to 3 l/m^2 minute 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 700 mm centres and at a uniform distance of 200 ± 5 mm from the highest point of the specimen.

The local mains water supply shall be an acceptable source providing 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.

A means of measuring the total amount of water supplied within an accuracy of 10%. The water spray apparatus shall be regularly calibrated.

A drain for the sprayed water which will 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.

D.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/m^2 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 ventilators may be blocked in order to achieve the required air pressures for test purposes.

Annex E – Tests on translucent assemblies

Contents

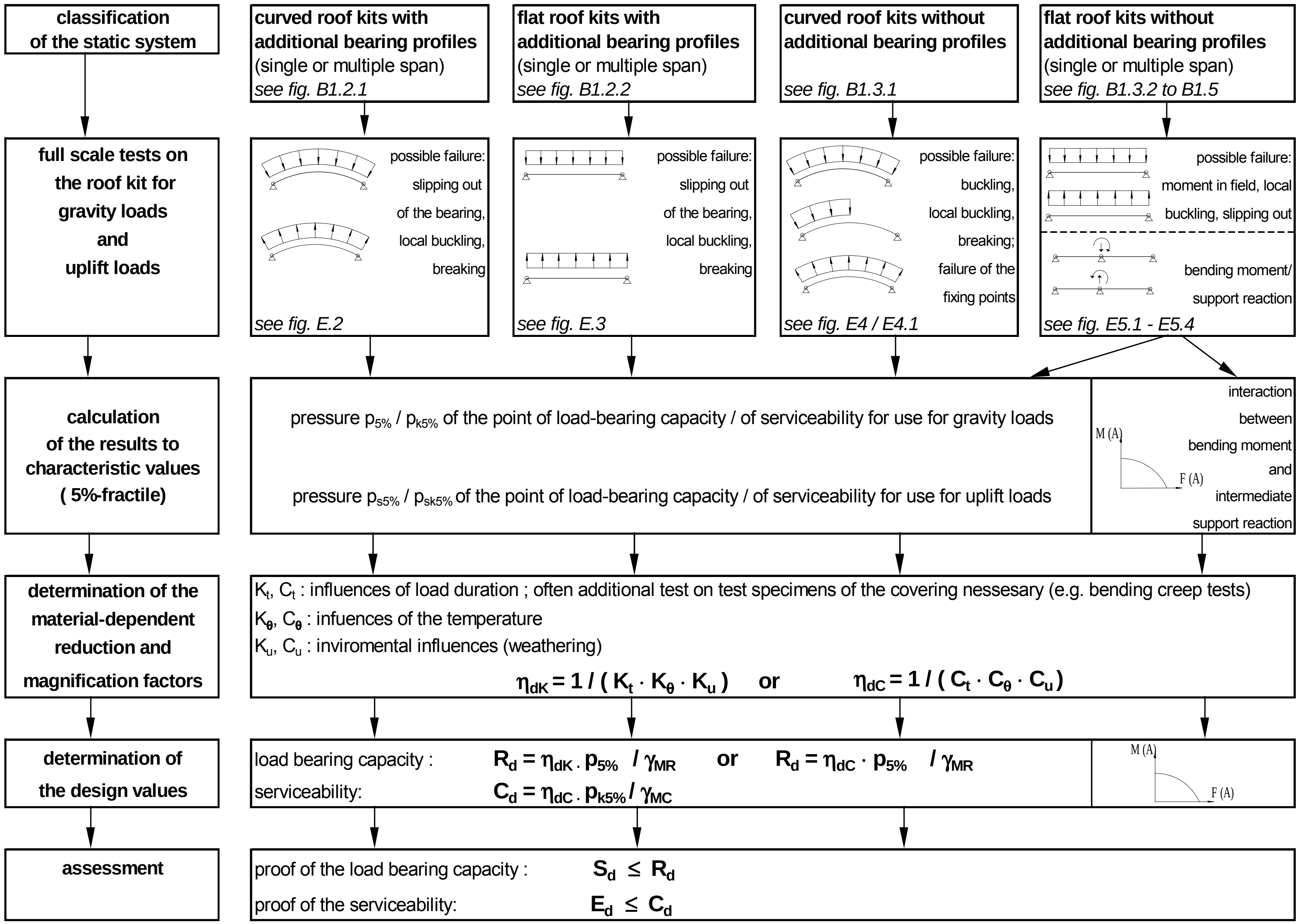
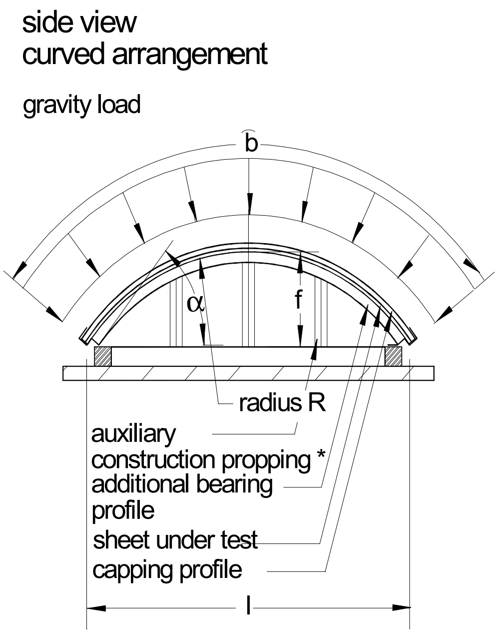
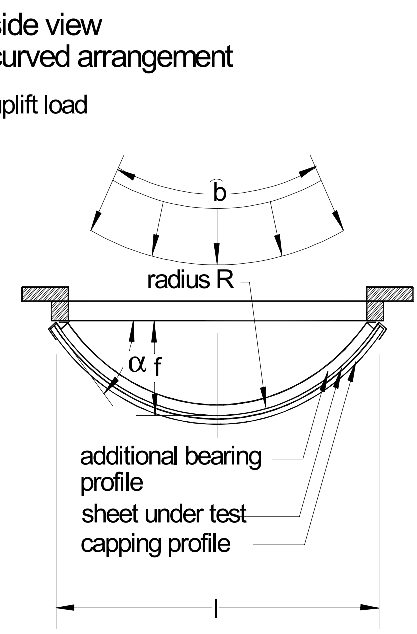
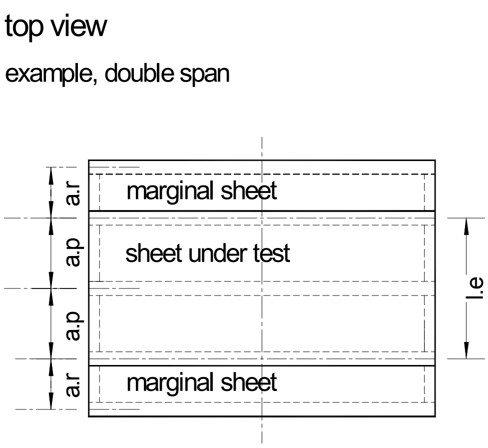
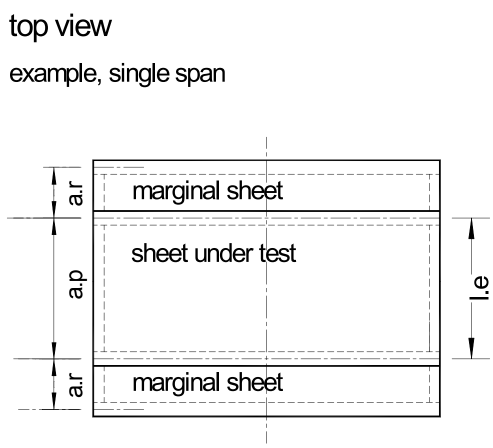


Fig E1 **Assessment of the load bearing capacity and serviceability of the plastic parts of a roof kit system by full scale tests**









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

* For use only where the sheet is under test.

Fig E2 Test set-up (schematic), gravity load and uplift load for curved roof kits with additional bearing profiles parallel to the span

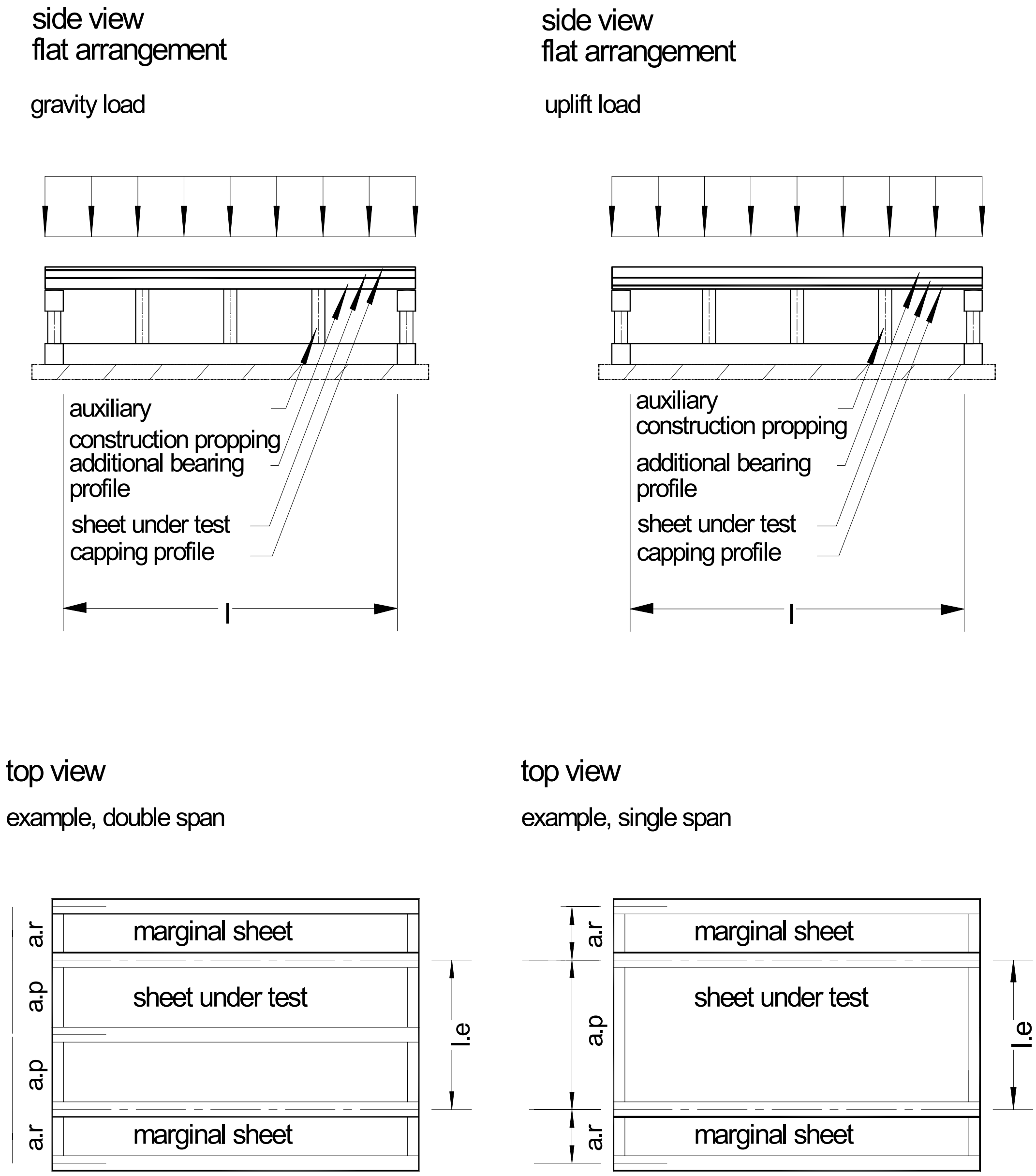


Fig E.3 **Test set-up (schematic), gravity load and uplift load for flat roof kits with additional bearing profiles parallel to the span**

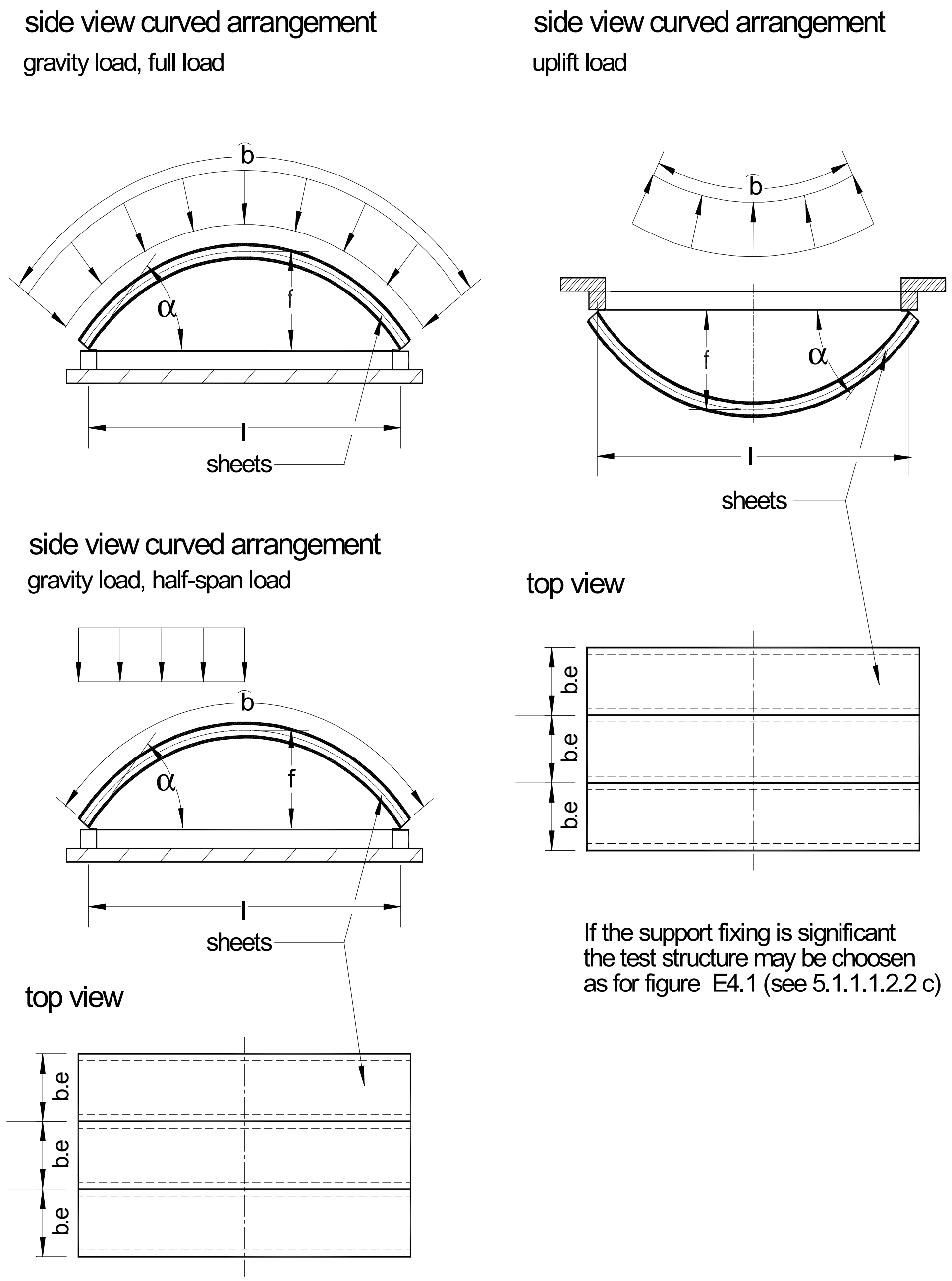
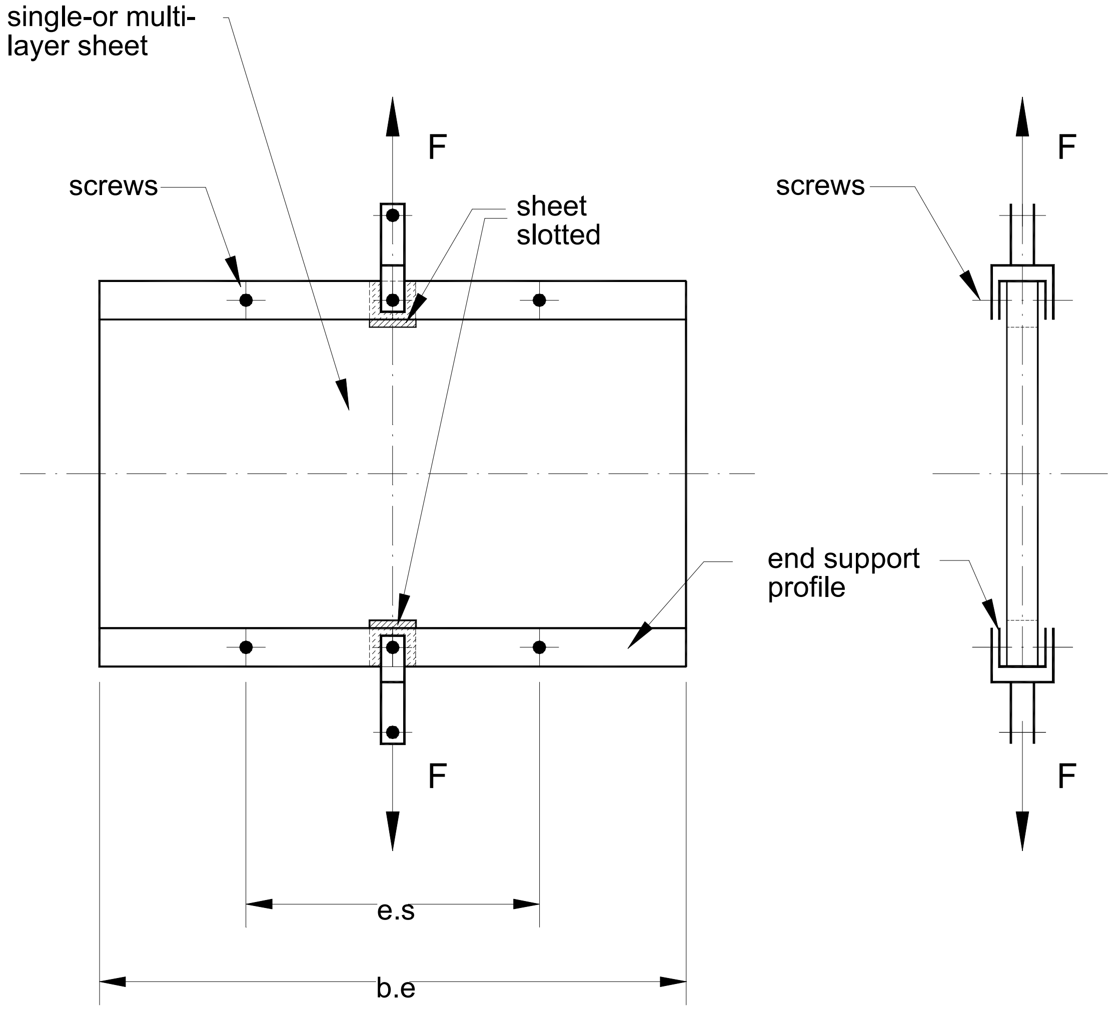


Fig E4 **Test set-up (schematic), gravity load (full load, half-span load) and uplift load for curved roof kits without additional bearing profiles and with single- or multi-layer sheet with joints**



e.s : distance between the screws

Fig E4.1 Test set-up (schematic), uplift load for roof kits without additional bearing profiles - system support by tensile test

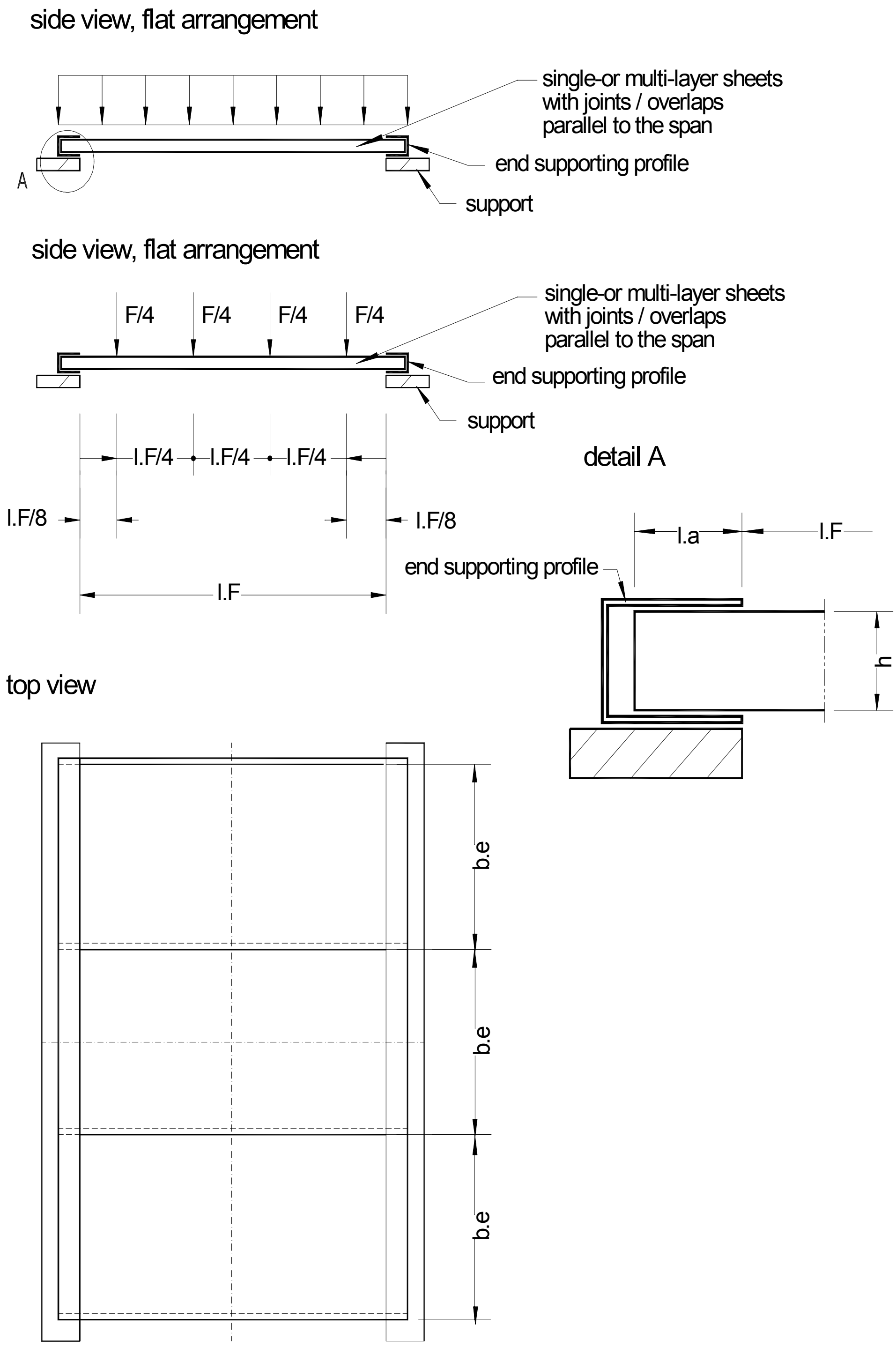


Fig E5.1 **Test set-up (schematic) for the determination of the bending moment capacity for single or multi-layer sheets with joints parallel to the span generally to to ENV 1993 - 1 - 3 (EUROCODE 3)**

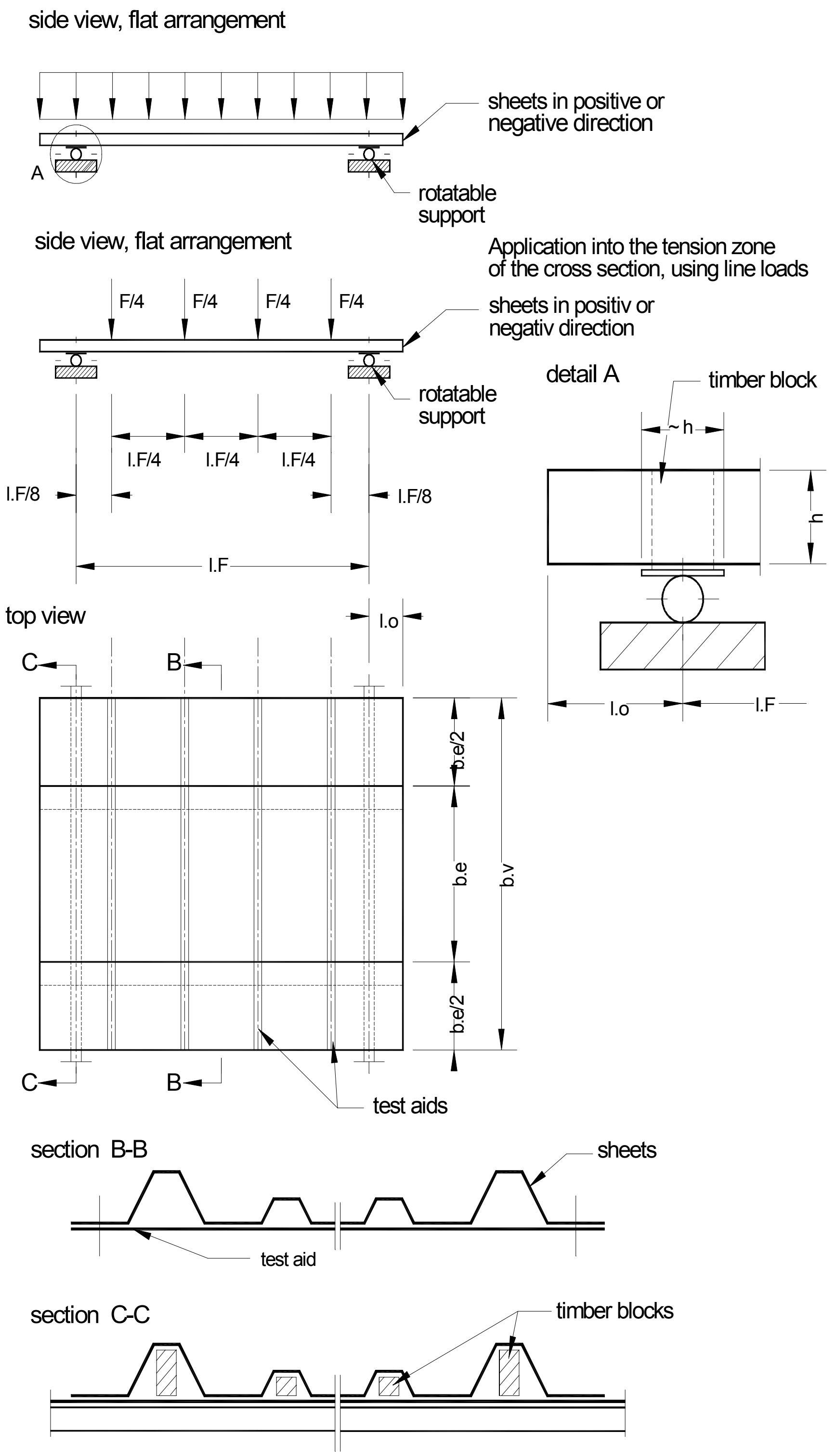


Fig E5.2 **Test set-up (schematic) for the determination of the bending moment capacity for profiled sheets when shear force is negligible, generally to ENV 1993 - 1 - 3 (EUROCODE 3)**

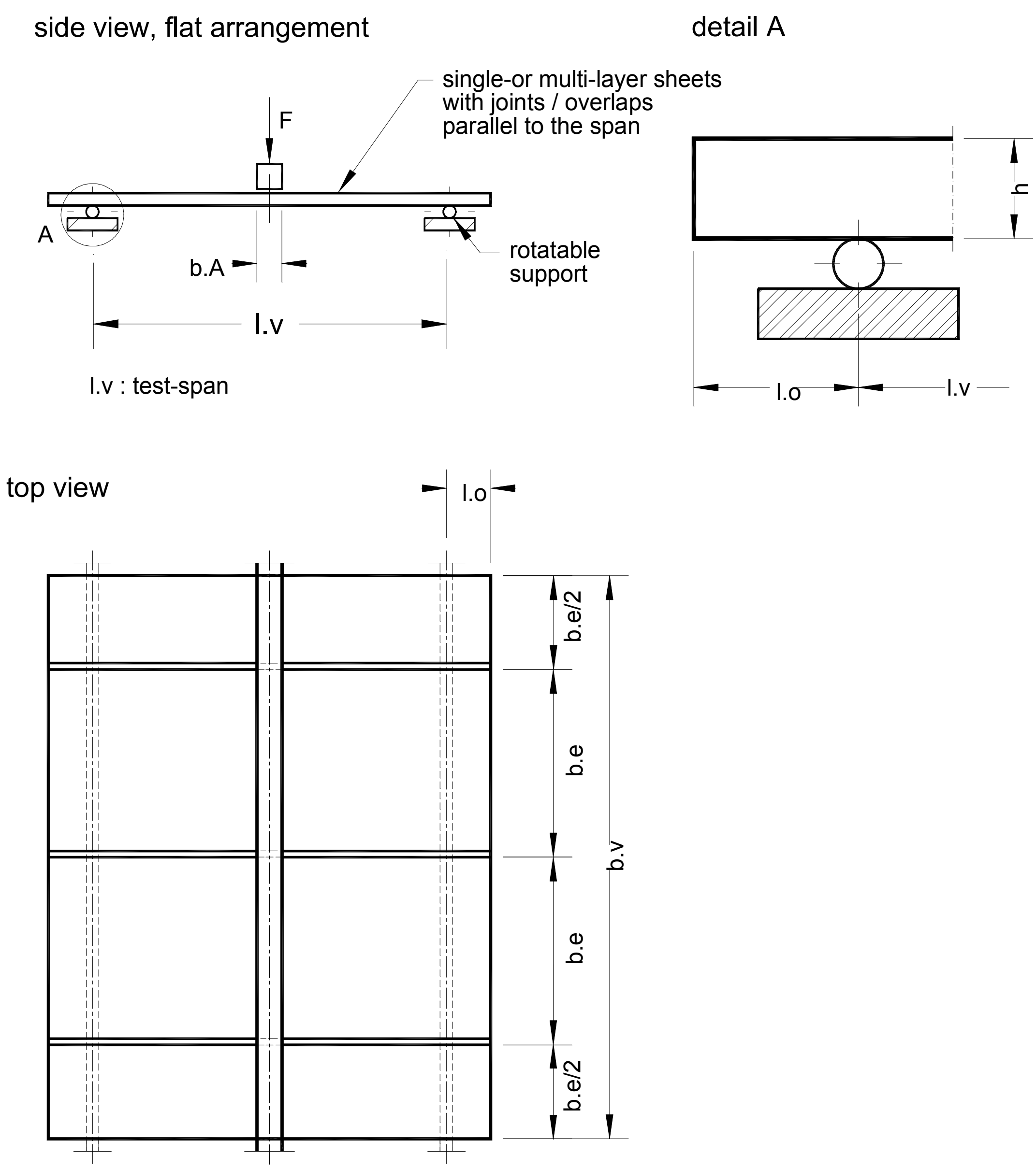


Fig E5.3.1 Test set-up (schematic) for the determination of the interaction between bending moment and intermediate support reaction under gravity load for single or multi-layer sheets with joints parallel to the span generally to ENV 1993 - 1 - 3 (EUROCODE 3)

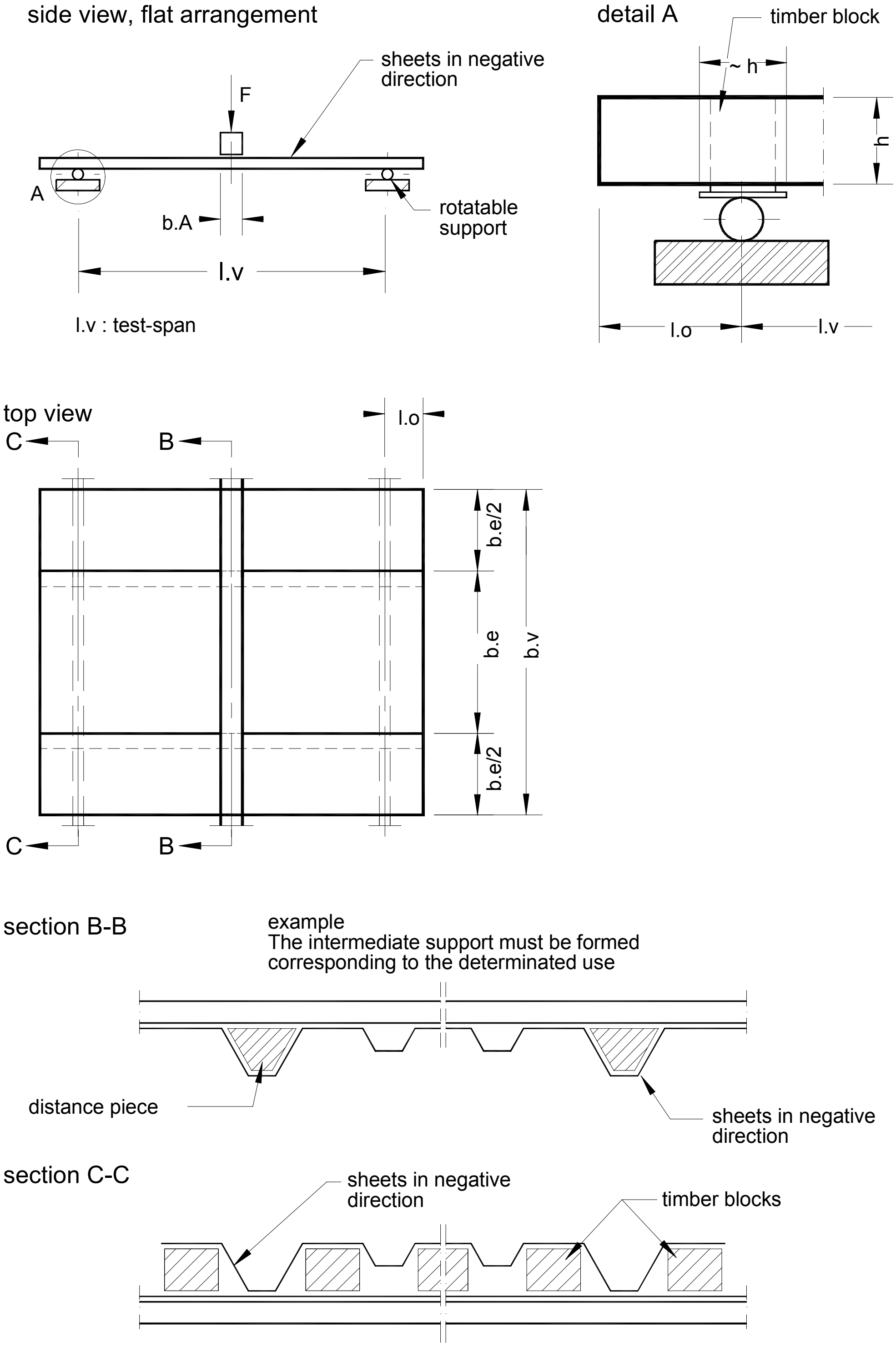


Fig E5.3.2 Test set-up (schematic) for the determination of the interaction between bending moment and intermediate support reaction under gravity loads for profiled sheets, generally to ENV 1993-1-3 (EUROCODE 3)

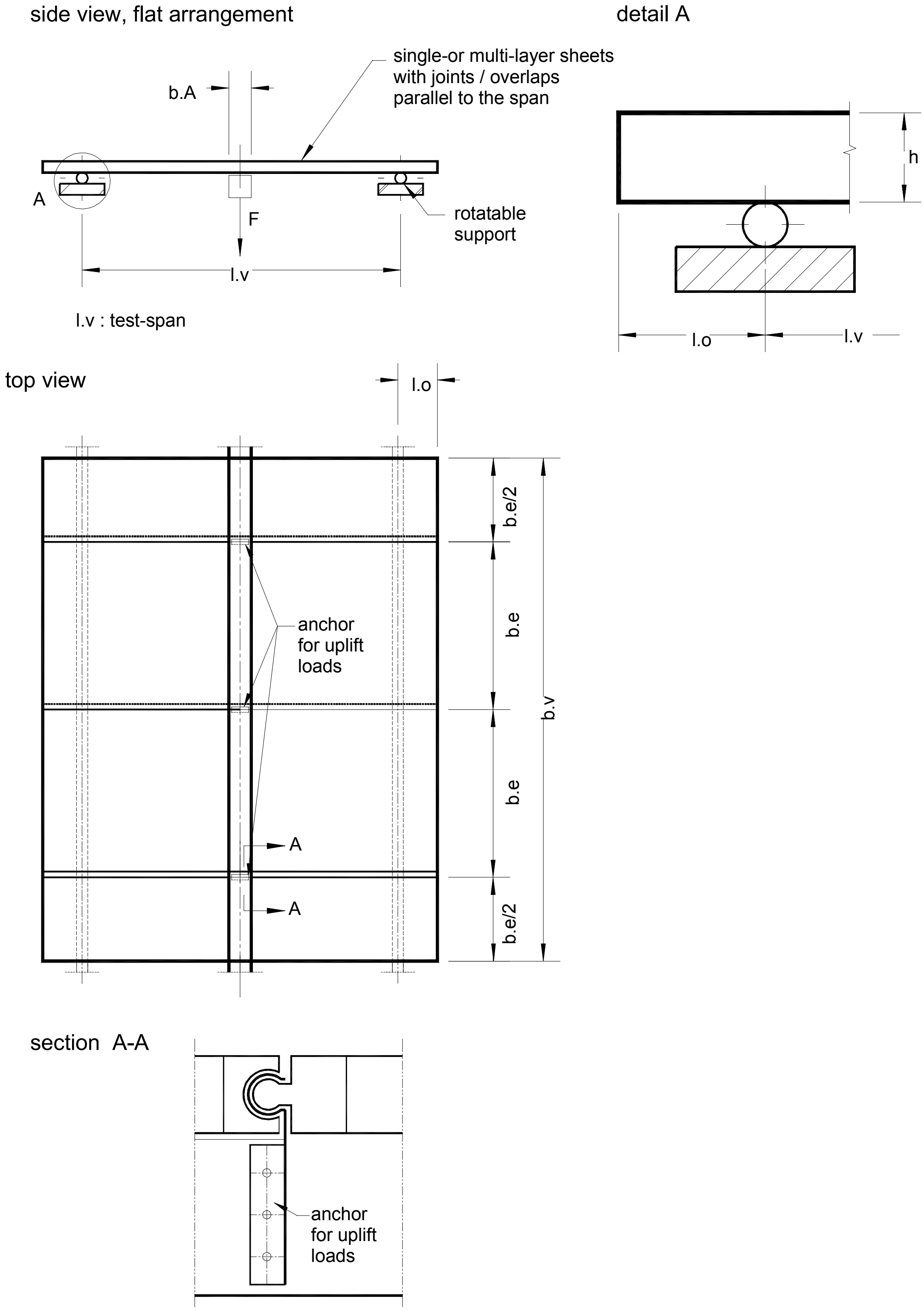


Fig E5.4.1 **Test set-up (schematic) for the determination of the interaction between bending moment and intermediate support reaction under uplift loads for single-or multi-layer sheets with joints parallel to the span generally to ENV 1993 - 1 - 3 (EUROCODE 3)**

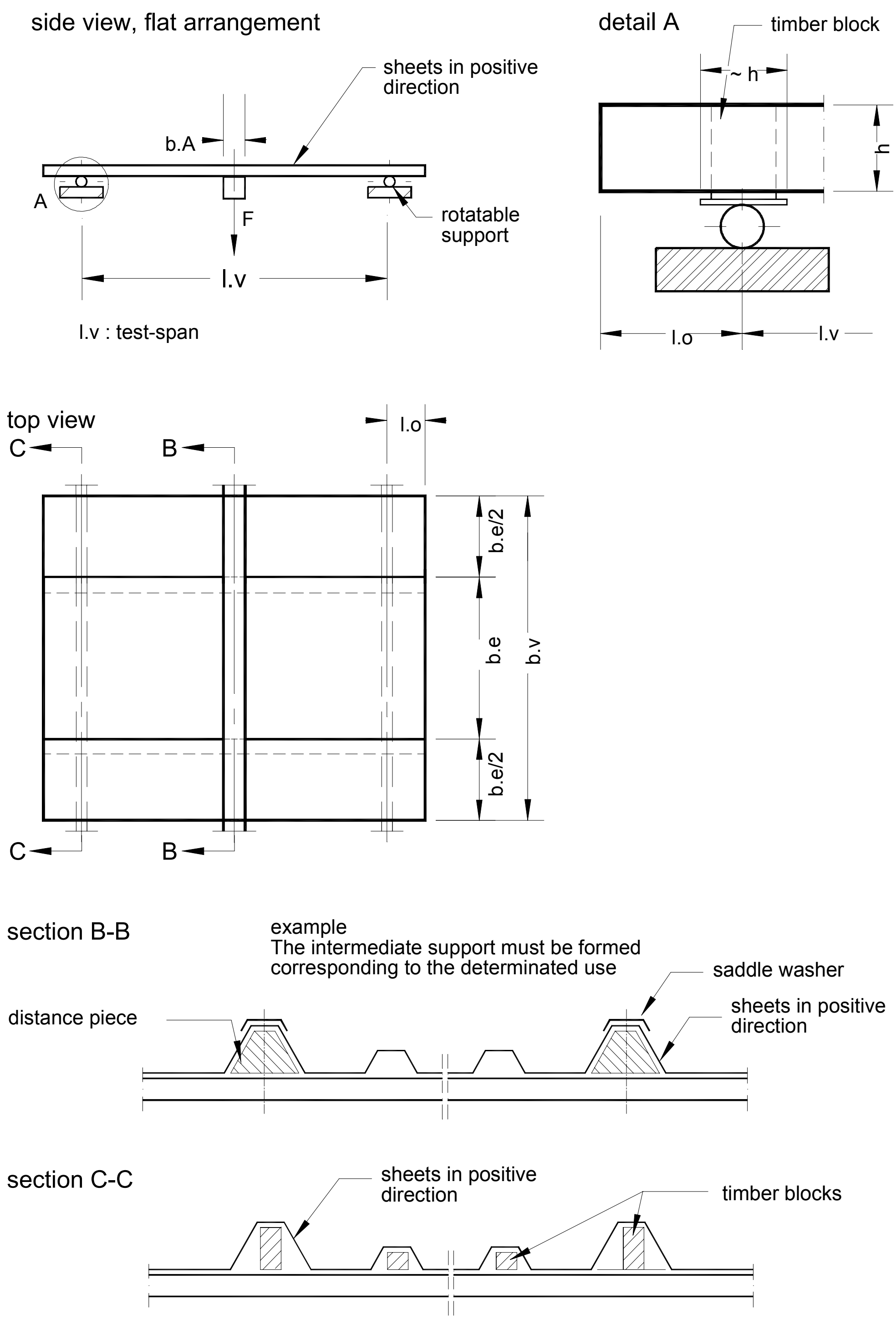
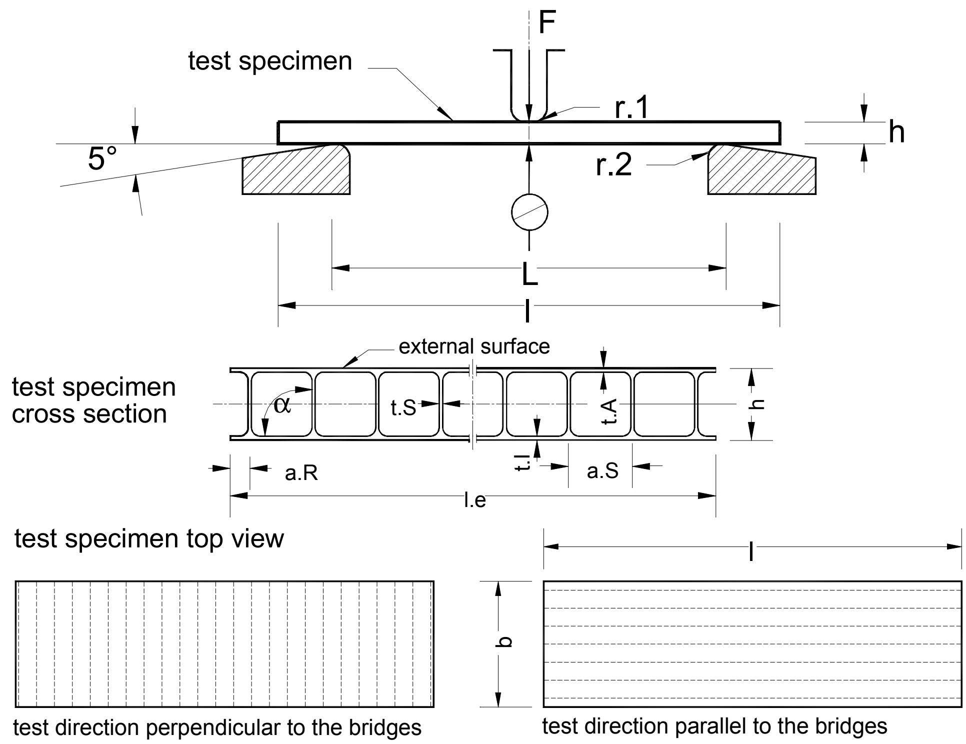


Fig E5.4.2 Test set-up (schematic) for the determination of the interaction between bending moment and intermediate support reaction under uplift loads for profiled sheets, generally to ENV 1993 - 1 - 3 (EUROCODE 3)

Annex F - Small-scale tests on translucent materials

Contents



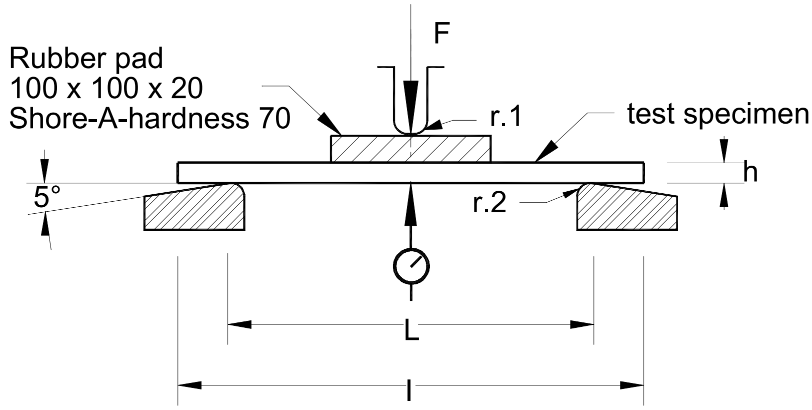
test conditions : - standard atmosphere EN ISO 291 - 23/50 - 2

- force application	:	external surface			
- test specimen thickness	:	h	=	10	mm
- test specimen width	:	b	=	80	mm
- test specimen lenght	:	l	=	500	mm
- support span					
test direction parallel to the bridges	:	L	=	200	mm
test direction perpendicular to the bridges	:	L	=	200 and 400	mm
- radius	:	r.1	=	(5 +/- 0,1)	mm
	:	r.2	=	(5 +/- 0,2)	mm
- test load					
test direction parallel to the bridges	:	F	=	175	N
test direction perpendicular to the bridges	:	F	=	20	N

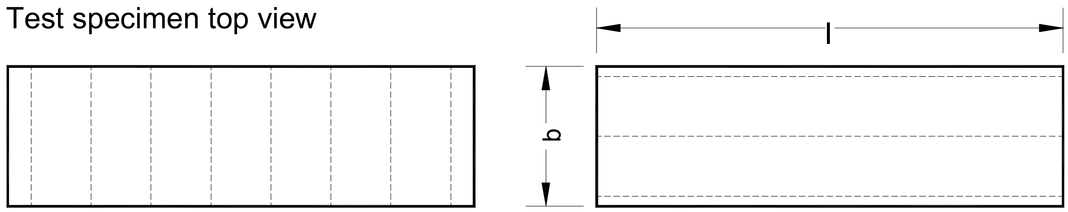
to determine :

- magnification factor C_t
- bending stiffness (both directions)
- shear stiffness (only in direction perpendicular to the bridges)
- requirement of the deflection after 0,1 h load duration for production control test

Fig F1.1 Creep-bending test (schematic) in addition to EN ISO 899 - 2 of a multi-wall sheet of PC (example)



Test specimen top view



test direction perpendicular to the bridges

test direction parallel to the bridges

Test conditions :

- standard atmosphere EN ISO 291 - 23/50 - 2

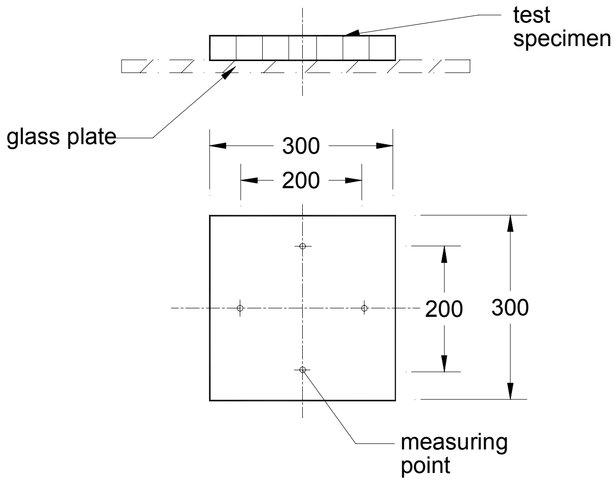
- force application	:	external surface			
- test specimen thickness	:	h	=	16	mm
- test specimen width	:	b	=	100	mm
- test specimen lenghth	:	l	=	500	mm
- support span	:	L	=	320	mm
- radius	:	r.1	=	(5 +/- 0,1)	mm
	:	r.2	=	(5 +/- 0,2)	mm
- loading rate	:	v	=	maximum 1% extreme fibre elongation per minute	

To determine :

- requirement of the bending strength
  for production control test

Fig F1.2 Short term test (schematic) supplementing EN ISO 178 for a multi-wall sheet of PMMA (example)

Dimensional stability after thermal conditioning
using a multi-wall sheet of PC as an example



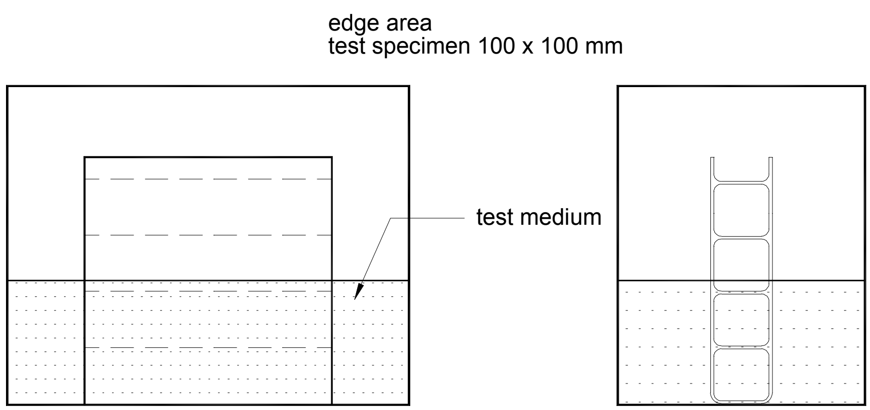
Test conditions :

- length of measurement = 200 mm
- conditioning time t = 60 min
- conditioning temperature 100° C ± 2° C
  in an air circulation oven
- cooling time in standard atmosphere
  t = 10 min

To determine :

dimensional change
in extrusion direction Δl in percent

Internal stress test using
a structured sheet of PMMA as an example



Test conditions :

- standard atmosphere
- test medium : ethyl acetate
- test time : 10 min

Testing :

Before testing the surface of the test specimen shall be cleaned with distillated water and it shall be conditioned ia a drier at a temperature of (23 ± 1) ° C for at least 24 hours.

Requirement :

After the test period crazing on the surface shall not be visible.

Fig F1.3 Test set-ups (schematic) to determine the dimensional stability after thermal conditioning supplementing EN 1013-4 and the internal stress test supplementing ISO 12017

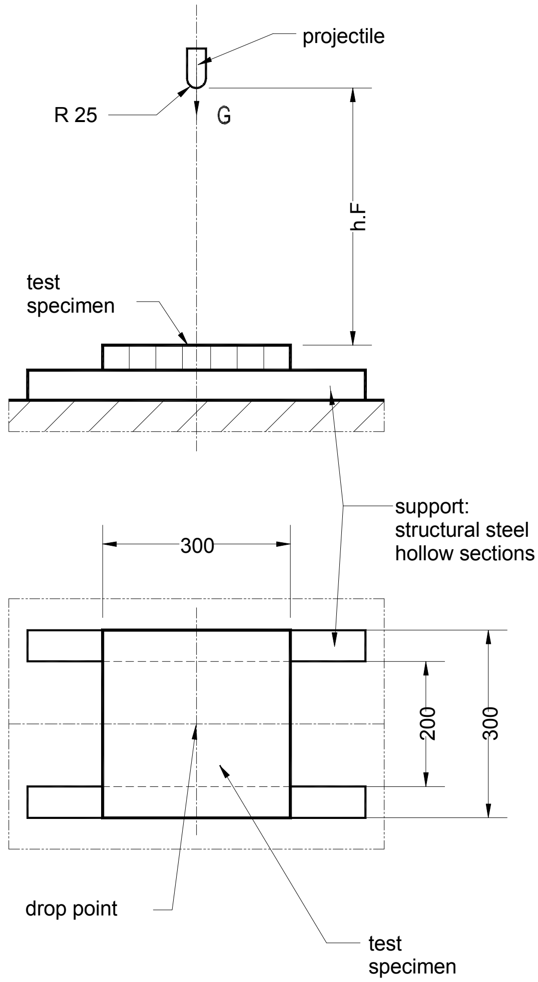
impact test

test conditions :

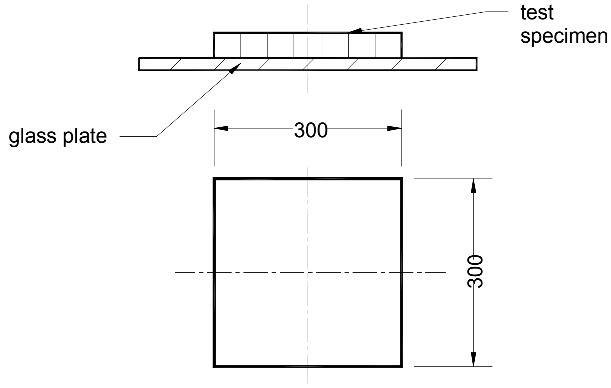
-temperature of test specimen	:	-20 °C ± 3 °C
-projectile mass	:	G = 1000 g
-fall height	:	h.F = 250 mm

To determine :

combination of projectile mass and drop height such that the test specimen shows no cracks



heat resistance test, for the example of a multi-wall sheet of PVC



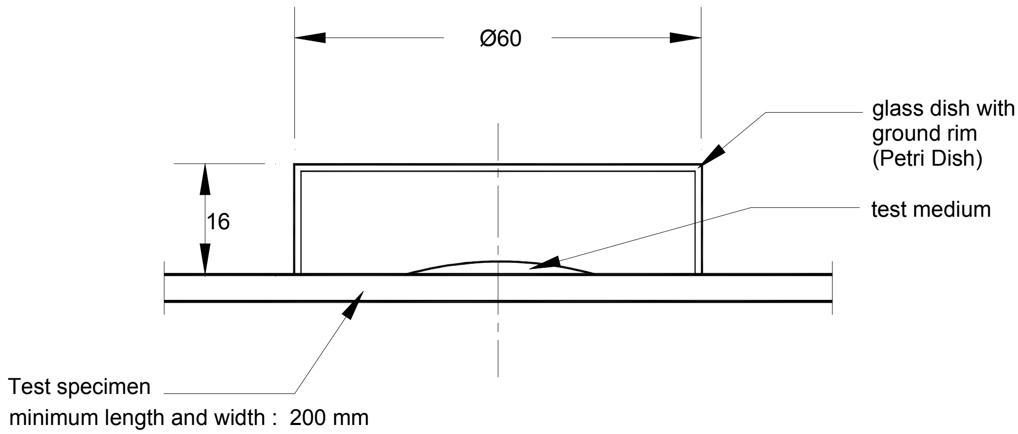
Test conditions :

- temperature 60 °C ± 5° C, time t = 30 min in an air circulation oven
- temperature increase every 5 min of 5° C until the surface of the profile has reached the glass plate

To determine :

- heat resistance as a temperature in degrees celsius

Fig F1.4 Test setups (schematic) to determine the falling weight impact resistance and the heat resistance supplementing EN 1013-1 (example)



Test conditions :

- standard atmosphere
- test medium : ethyl acetate
- test volume : 0,2 ml
- test time : 1 h

Testing :

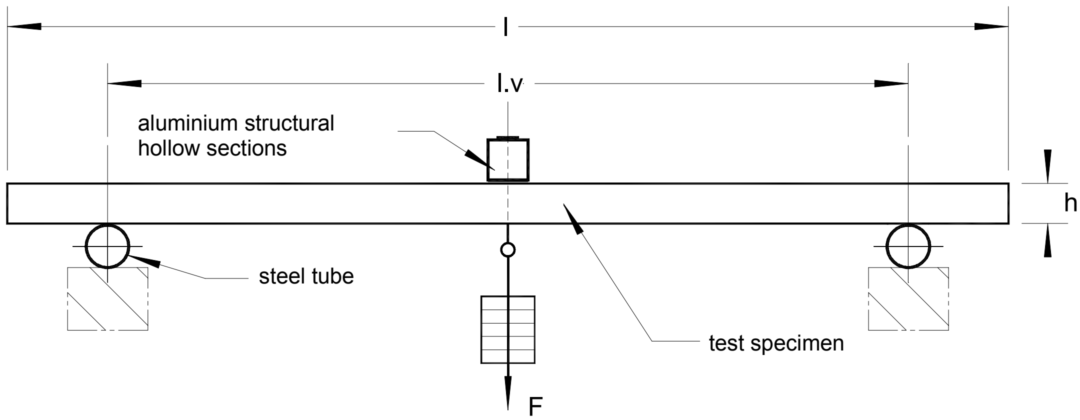
Before testing the surface of the test specimen has to be cleaned with distillated water and conditioned in a drier at a temperature of (23 ± 1) for at least 24 hours.

The test medium shall be applied on the surface of the test specimen by a graduatted pipette and covered by a glass dish.

Requirement :

After the test period crazing on the surface shall not be visible.

Fig F2.1 Internal stress test supplementing ISO 12017 for a solid sheet of PMMA (example)



Test conditions :

- standard atmosphere				
- force application	: internal surface			
- test specimen thickness	: h	=	40	mm
- test specimen width	: b	=	500	mm
- test specimen lenght	: l	=	1000	mm
- support span	: l.v	=	800	mm
- test load	: F	=	750	N

Requirement :

maximum value of deflection after 0,1 h load duration :

f(0,1) = 11,8 mm

Fig F3.1 Creep-bending test (schematic) supplementing EN ISO 178 for multi-layer sheet of PC (example)

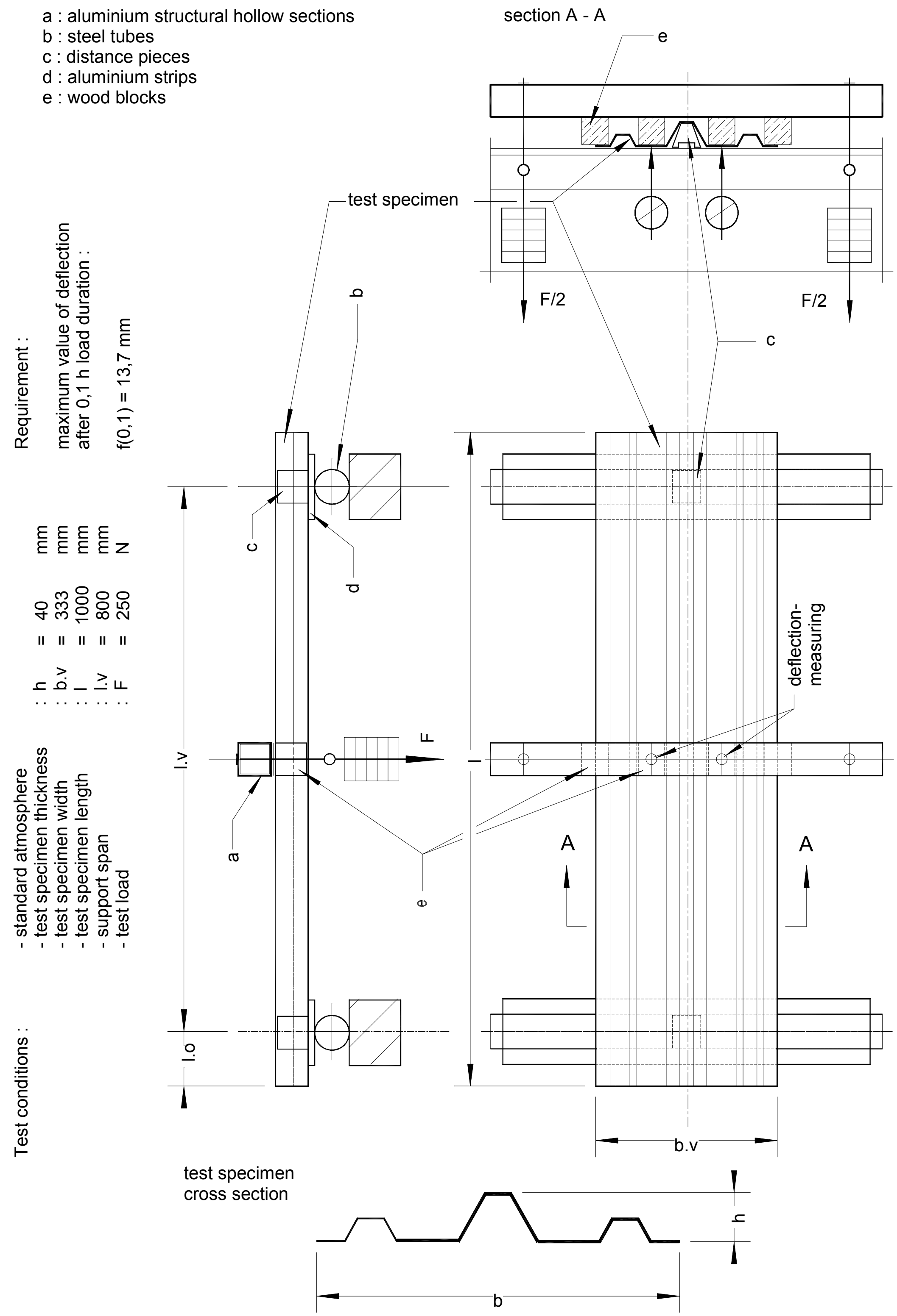


Fig F4.1 **Test set-up (schematic) to determine the magnification factor of the load duration of a trapezoidal profiled sheet of PVC based on EN 1993 - 1 - 2 (EUROCODE 3) (example)**

Impact test

test conditions	-temperature of test specimen	:	-20 °C ± 3 °C
	-projectile mass	:	G = 2400 g
	-fall height	:	h.F = 1000 mm

To determine : combination of projectile mass and drop height such that the test specimen shows no cracks

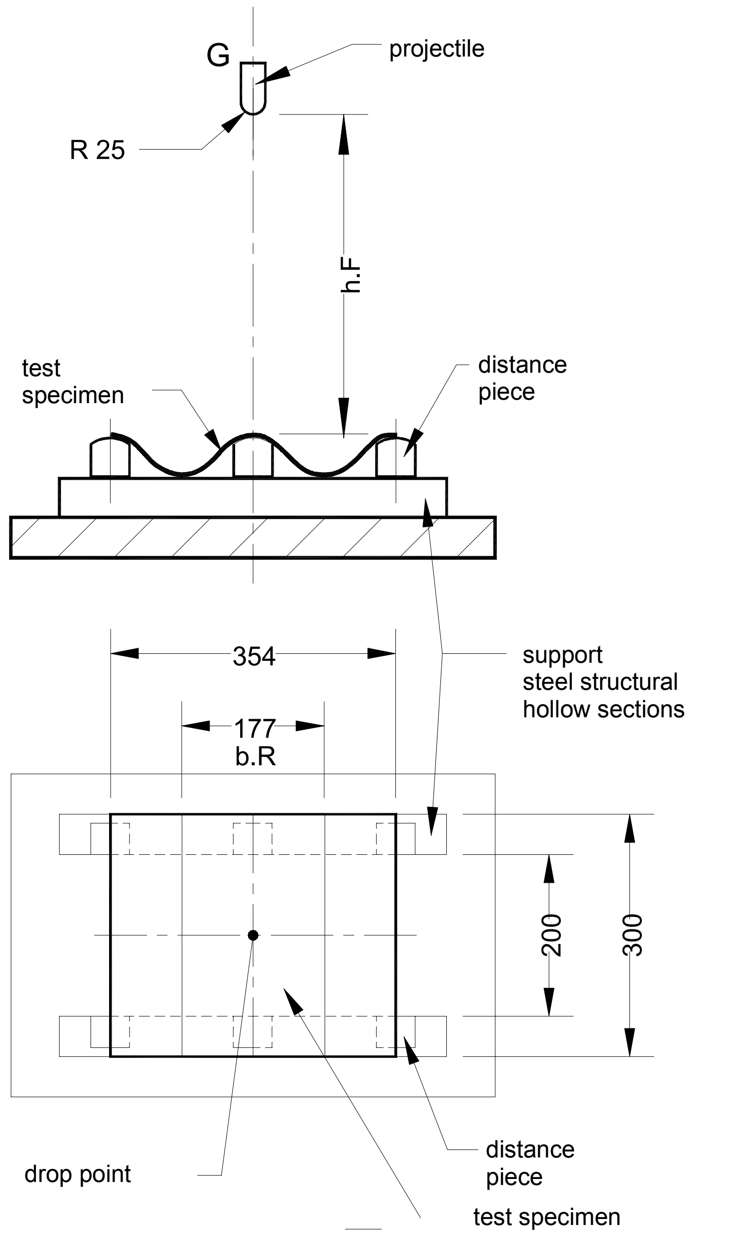


Fig F4.2 Test set-up (schematic) to determine the impact resistance of a sinusoidal shaped sheet of PVC supplementing EN 1013-1 and EN 1013-3 (example)

Annex G - Tests on Fasteners

Axial loading test

This test method determines the axial failure of a fastener under static loading, irrespective of the failure mode.

Test apparatus

Test machine, which can be operated with static tensile forces.
Load cell to measure the force.
Deformation gauge.
Holding device for the aluminium profile.
Device for applying the force to the fastener. The steel jaws holding the fastener should be 10 mm thick. See principle in Figure G.1.

Test samples

The samples shall be representative of the use/application of the fastener in the profile.

The fasteners are stored for two weeks in the testing laboratory at 23 ± 2ºC and 50 ± 5 % RH.

The fasteners shall be installed in the specified aluminium profile and with the corresponding cap profile according to the manufacturer's installation guide.

Procedure

The fastener and the aluminium profile are secured in the test machine in such a manner that any effects of bending are as far as possible avoided.

Two fasteners are installed in the aluminium profile with a distance, L, which is the maximum distance between the fasteners.

The machine shall be operated at a speed of 5 - 10 mm/min.

The test is performed at 23 ± 2ºC, 50 ± 5 % RH.

10 samples of fastener and substrate are tested.

Expression of results

The pull-out strength of the fastener is found for each sample. The mean value is calculated and the failure mode is noted. The maximum distance, L, is noted.

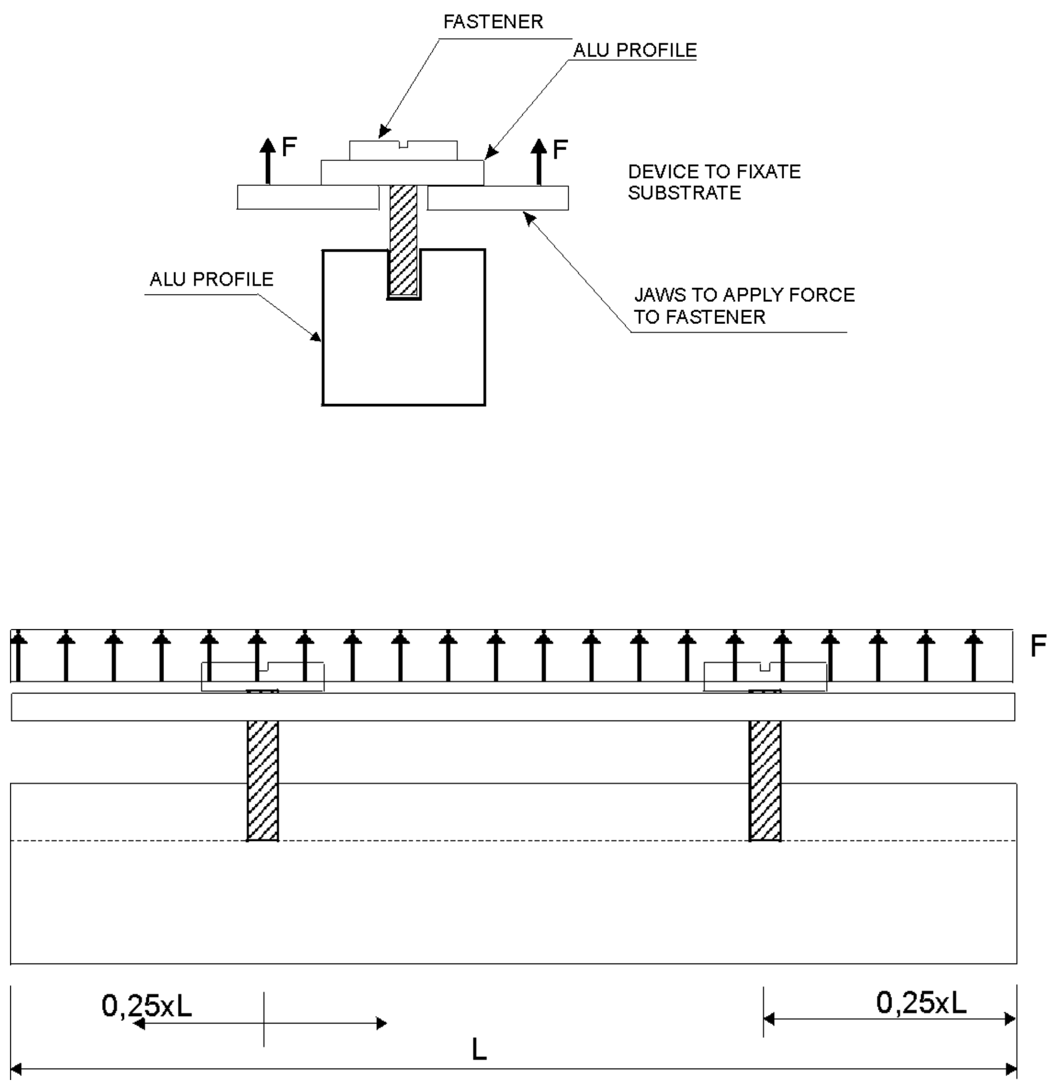


Figure G.1 Principle of axial loading test

Annex H - Material-Dependent Reduction and Magnification Factors

H.1 General

To determine the serviceability and load-bearing capacity of the translucent plastic components of a roof kit, in addition to the general safety coefficients, material-dependent reduction or magnification factors must also be taken into account. These material factors are not safety coefficients but describe the changes in the component behaviour over the period of use, or the effect of the load. Depending on the nature of failure of the plastic components of the roof kit, i.e. deformation-induced or insufficient material strength, the relevant decisive parameters of the material must be used to determine the reduction or magnification 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 reduction factor K for strength or magnification factor C for deformation. Alternatively, the loads assumed for design can be adjusted by factor K or C.

Factors are to be taken into account for:

- load duration influences (K_t, C_t)
- ageing and environmental influences (K_u, C_u)
- and temperature influences (K_θ, C_θ)

Further factors can also be decisive unless adequately covered in the determination of the component strength. This could, for example, be necessary due to better properties of the component tested than in general production or due to frozen stress (e.g. in PMMA) in production. The literature identifies these material factors partly as:

$A_{1l} = C_t$; $A_{1B} = K_t$; $A_{2l} = C_u$; $A_{2B} = K_u$; $A_{3l} = C_\theta$; $A_{3B} = K_\theta$

H.2 Determination of Material-Dependent Reduction or Magnification Factors

To determine the material-dependent reduction or magnification factors, tests on comparison specimens and (where there is adequate experience) generally recognised parameters can be used.

H.2.1 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. 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. H.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.

Fig H.1 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 largely 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-elongation curves can be used to determine the reduction factor K_t (Fig H. 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 H.3 to H.8 show examples of tests on test specimens for determination of the magnification factor C_t. The examples selected are creep bending tests on a solid sheet of polymethylmethacrylate PMMA (Figs H.3 to H.4), a multi-wall sheet of polycarbonate PC (Figs. H 5 to H 7) and a trapezoidal profiled sheet of polyvinyl chloride PVC (Figs. H 8 and H 9).

Fig H. 3 shows the diagrammatic structure of the creep-bending test on the solid PMMA sheet with the test conditions. Fig H. 4 shows the measured deflection f as a function of the load duration t in double-logarithmic form. The load-deflection behaviour corresponds to the known material behaviour of PMMA. The magnification factor C_t of the deformation was determined here from the ratio of the deflection at a reference time t of 2000 h, corresponding to an assumed snow loading period of approx. 3 months, to the short-term deflection after 0.1 h.

Fig H. 5 shows the test structure of a creep bending test with test conditions for a PC multi-wall sheet. As multi-wall sheets are normally used in roof systems with supporting profiles, in which the load is transferred both in the direction of and transverse to the webs, the test on the plate must be carried out in two directions. Fig H.6 shows the deflection f as a function of the load duration t transverse to the web path. Here two different spans must be tested in order to calculate the bending and shear strength. The deflection for the longitudinal direction is shown in Fig H. 7. Here no additional span is required, as the deflection part of the transverse load is relatively low. The results largely correspond to the known behaviour of polycarbonate. In addition to the material creep, because of the geometry an increase in buckling effects on the compressed cross-section parts can influence the deflection behaviour in multi-wall sheets.

Fig H. 8 shows a test structure using the example of a trapezoid profiled PVC sheet. As such sheets are used in roof construction systems with supporting profiles transverse to the profiling, here only a test in the direction of the load transfer, i.e. the profile direction, is necessary. The test specimen selected is a representative profile section. The load is applied to the drawn cross-section parts to take full account of buckling effects. Fig H.9 shows the deflection f as a function of the load duration t. In comparison with known material behaviour of PVC, a more linear increase in deflection appears in a double-logarithmic system. This is essentially due to the reduction in effective width due to bulge effects in the compressed cross-section parts. The magnification factor C_t determined in this example is therefore greater than in solid sheets of the same material. Such profiled sheets should be assessed for the positive and negative stress direction.

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, and 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.

The tension to be applied, for testing, to verify the reduction factor K_{t2x10^5} for a reference time of $2x10^5$ h can be calculated on the basis of the 5%-fractile of the short -term strength as follows:

$$\sigma_{100h} = \sigma_{B5\%} / (K_{t2x10^5})^{0,55}$$

In the so called 24h-bending-test (fig H.10) under the applied tension of e.g. 15% of the breaking moment, the creep modulus can be determined by

$$E_C = E_{1h} (f_{1h} / f_{24h})^{3,6}$$

The creep modulus is :

$$E_C = E / (1 + \varphi_t)$$

By the same test a comparison value can be calculated for the short-term modulus

$$E_{CO} = E_{1h} (f_{1h} / f_{24h})^{-1,4} = E$$

or for the creep factor φ_t

$$\varphi_t = (f_{1h} / f_{24h})^{-5,0} – 1$$

Table H1 below shows examples of values for factors K_t and C_t for some plastics and various reference times of load duration.

Table H1:

Factor/reference time		Polycarbonate (PC)	Polymethyl-methacrylate (PMMA)	Polyvinyl-chloride (PVC)	Textile glass-reinforced unsaturated polyester resin (GRP), tangled fibre laminate with 35% glass mass
K_t C_t	24 h (1 day)	1.20 1.10	1.25 1.20	1.35 1.30	1.15 – 1.20 [1)] 1.20 – 1.25 [1)]
K_t C_t	650 h (approx. 1 month)	1.25 1.15	1.35 1.25	1.50 1.45	1.25 – 1.30 [1)] 1.35 – 1.40 [1)]
K_t C_t	2000 h (approx. 3 months)	1.30 1.20	1.40 1.30	1.60 1.50	1.30 – 1.35 [1)] 1.40 – 1.45 [1)]
K_t C_t	2×10^5 h (approx. 20 years)	1.60 1.50	1.70 1.60	2.00 1.80	1.50 – 1.60 [1)] 1.60 – 1.70 [1)]

[1)] Values depend greatly on the proportion of glass mass, the reaction resin and the heat treatment.

H.2.2 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).

Table H2 below gives example values for the factors K_u, C_u for some plastics under normal open-air weathering.

Table H2:

Factor	Polycarbonate (PC)	Polymethyl-methacrylate (PMMA)	Polyvinyl-chloride (PVC)	Textile glass-reinforced unsaturated polyester resin (GRP), tangled fibre laminate with 35% glass mass
K_u C_u	1.10 [2)] 1.10 [2)]	1.05 [2)] 1.05 [2)]	1.20 [2)] 1.00 [2)]	1.0 to 1.2 [3)] 1.0 to 1.2 [3)]

[2)] With normal protection (e.g. additional surface layer, UV stabiliser)
[3)] Depends greatly on the surface layers (e.g. protective layer, top coat, gelcoat), the reaction resin and the type of glass.

H.2.3 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-elongation behaviour (Fig H.11) or the shear modulus curve (Fig H.12).

Table H3 below gives example values for the factors K_θ, C_θ for some plastics.

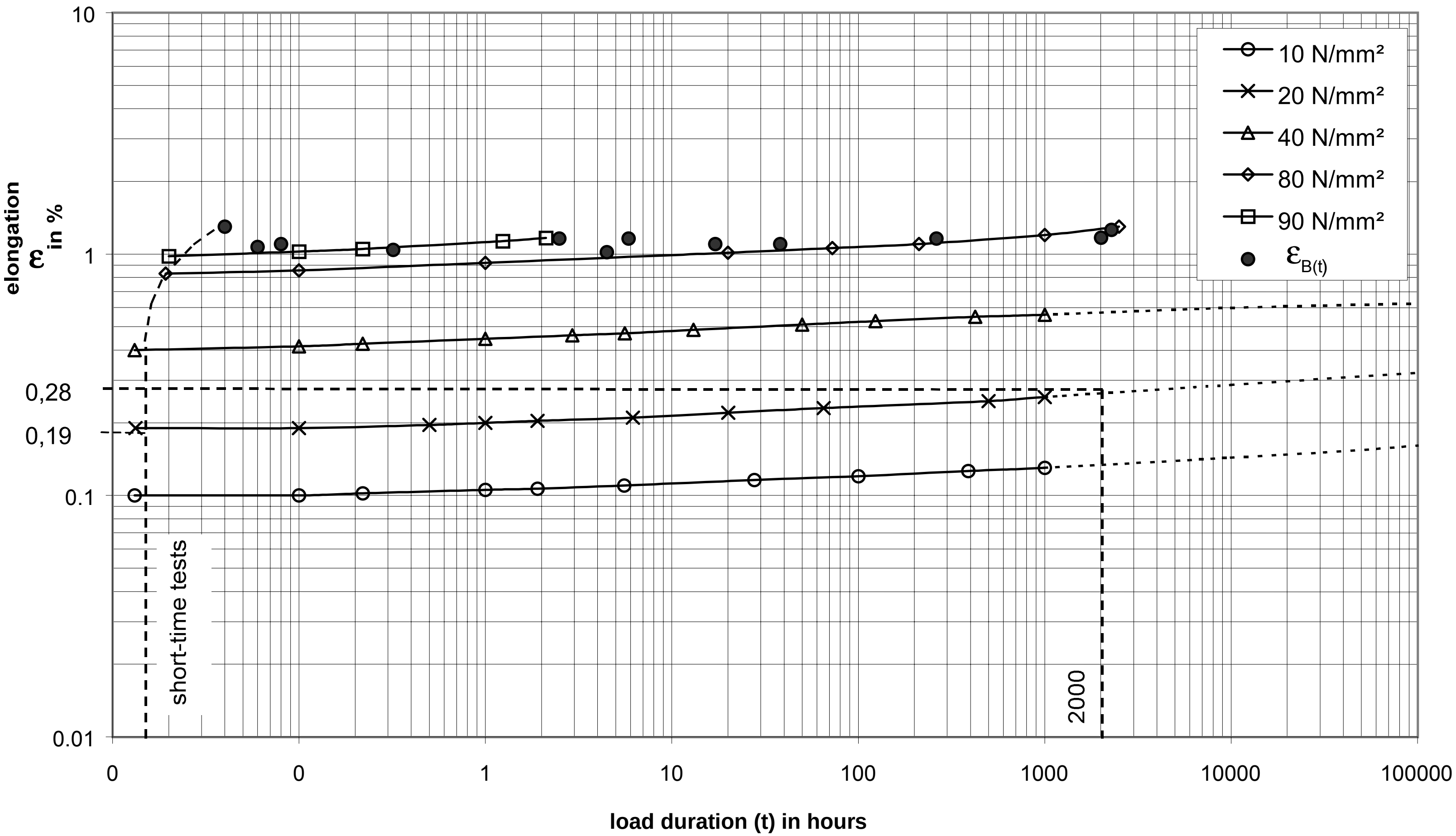
Table H3:

Factor	Polycarbonate (PC)	Polymethyl-methacrylate (PMMA)	Polyvinyl-chloride (PVC)	Textile glass-reinforced unsaturated polyester resin (GRP), tangled fibre laminate with 35% glass mass
K_θ C_θ	1.3 / 70°C 1.2 / 70°C	1.6 / 60°C 1.5 / 60°C	2.0 / 55°C 1.5 / 55°C	1.1 - 1.3 / 60°C [4)] 1.1 - 1.3 / 60°C [4)]

[4)] Depends greatly on the reaction resin.

Annex H Figures

Contents



$C_t = \varepsilon_2 / \varepsilon_1$

$= 0{,}28 / 0{,}19$

$= 1{,}47$

Fig. H1: Time - elongation - curves of glass-reinforced unsaturated polyester resin tangled fibre laminate with 30% glass mass

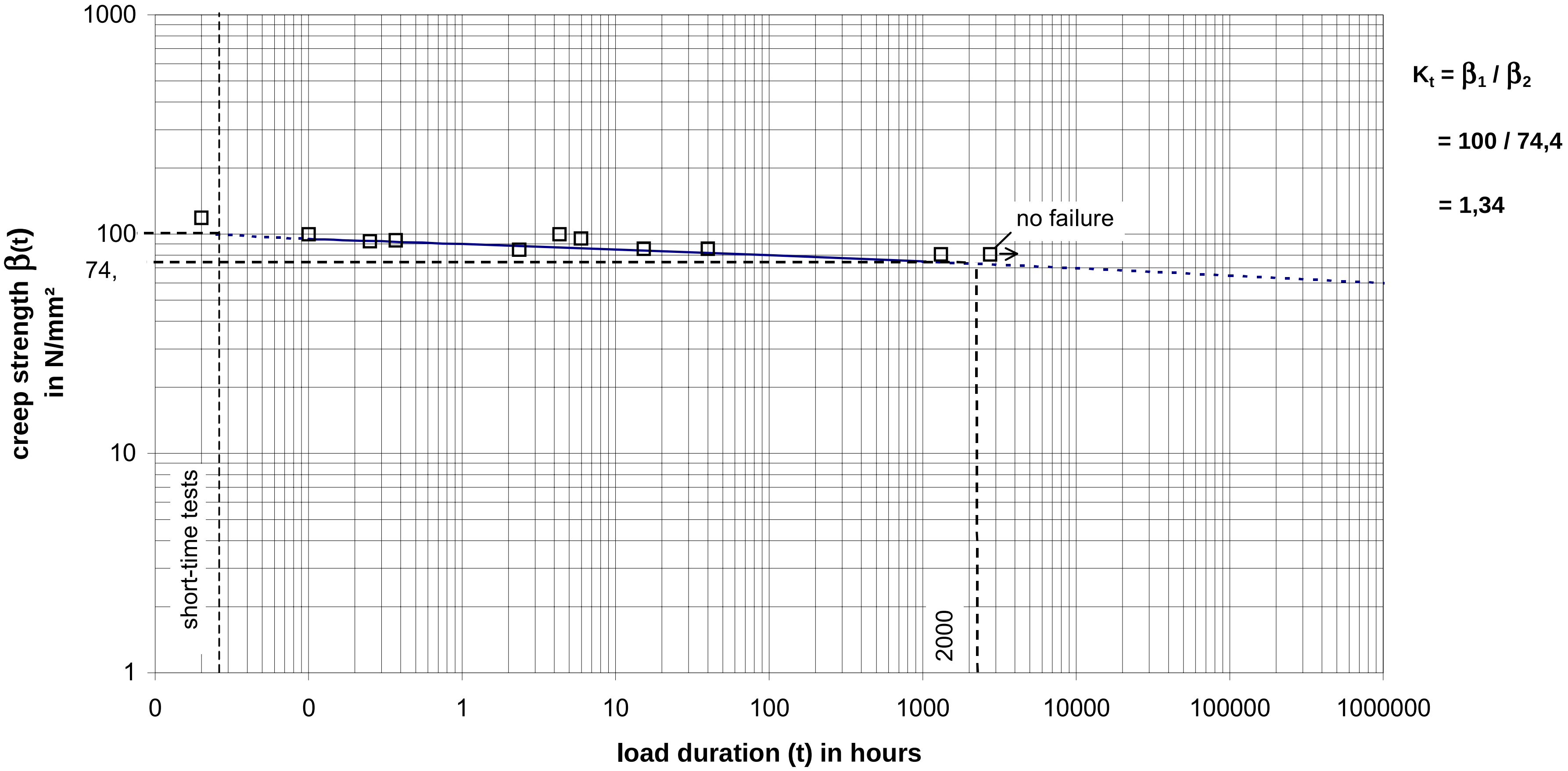
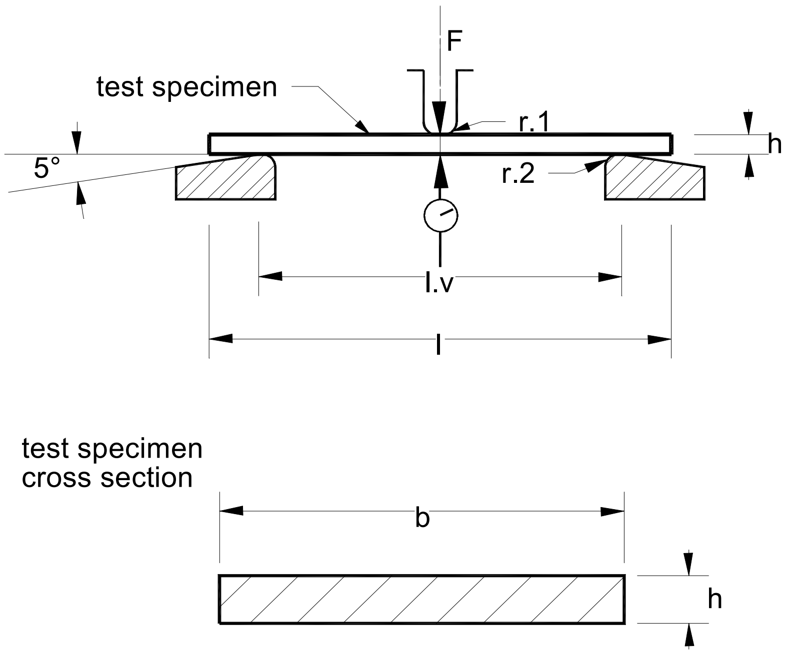


Fig. H2 : Time - break curves of a textile glass-reinforced unsaturated polyester resin tangled fibre laminate with 30 % glass mass



Test conditions :

- standard atmosphere					
- test specimen thickness	:	h	=	3	mm
- test specimen width	:	b	=	50	mm
- test specimen length	:	l	=	70	mm
- support span	:	l.v	=	60	mm
- radius	:	r.1	=	(5 +/- 0,1)	mm
	:	r.2	=	(5 +/- 0,2)	mm
- test load	:	F	=	45	N

Fig H.3 Creep-bending test (schematic) supplementing EN 63 for a solid sheet of PMMA (example)

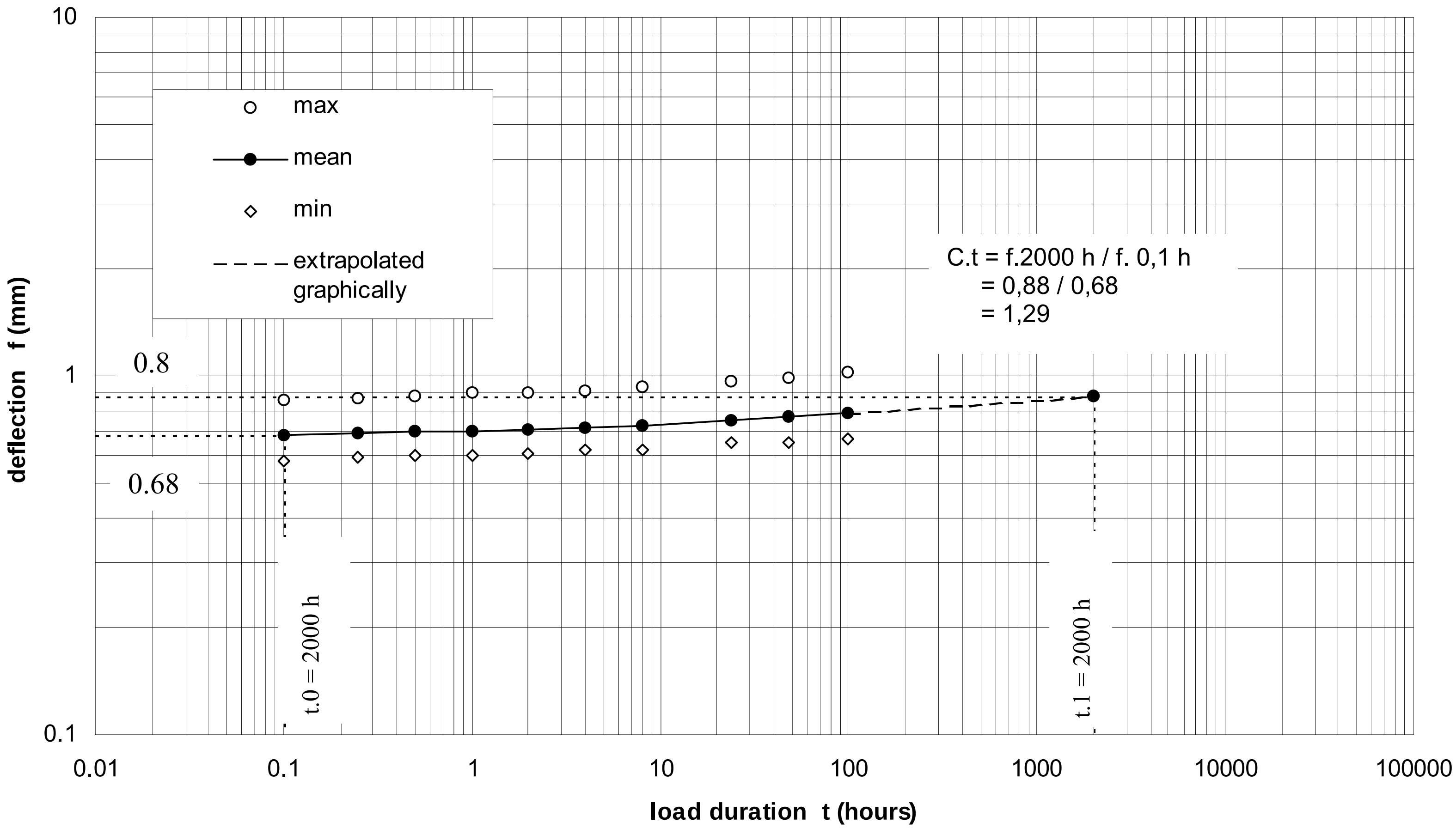
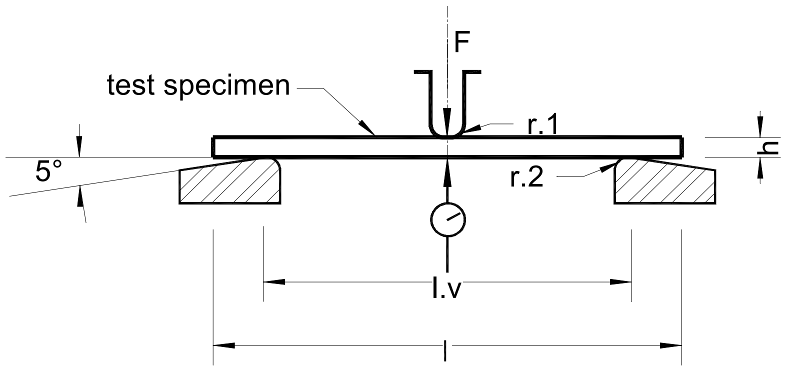
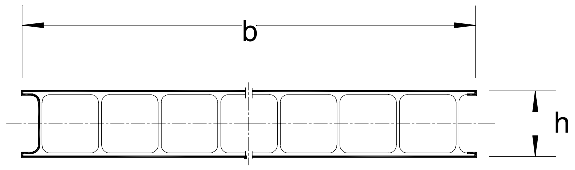


Fig H.4 Deflection (f) as a function of the load duration (t) for a solid sheet of PMMA (example



test specimen
cross section



Test conditions :

- standard atmosphere					
- surface of force application	:	face			
- test specimen thickness	:	h	=	10	mm
- test specimen width	:	b	=	80	mm
- test specimen length	:	l	=	500	mm
- support span					
test direction parallel to the bridges	:	l.v	=	200	mm
test direction perpendicular to the bridges	:	l.v	=	200 and 400	mm
- radius	:	r.1	=	(5 +/- 0,1)	mm
	:	r.2	=	(5 +/- 0,2)	mm
- test load					
test direction parallel to the bridges	:	F	=	175	N
test direction perpendicular to the bridges	:	F	=	20	N

Fig H5 Creep-bending test (schematic) supplementing EN 63 for a multi-wall sheet of PC (example)

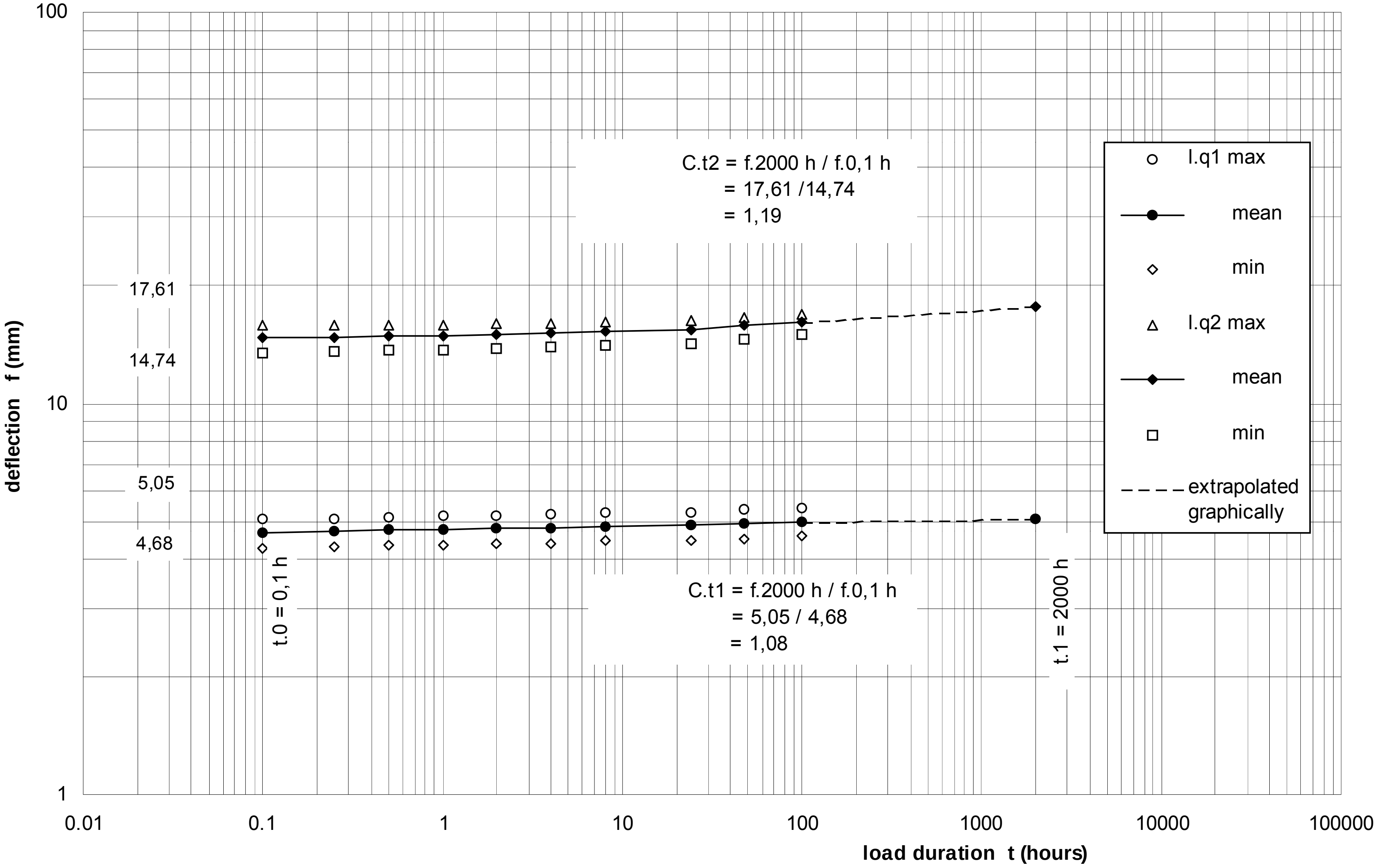


Fig H.6 Deflection (f) as a function of the load duration (t) for multi-wall PVC sheet (example)

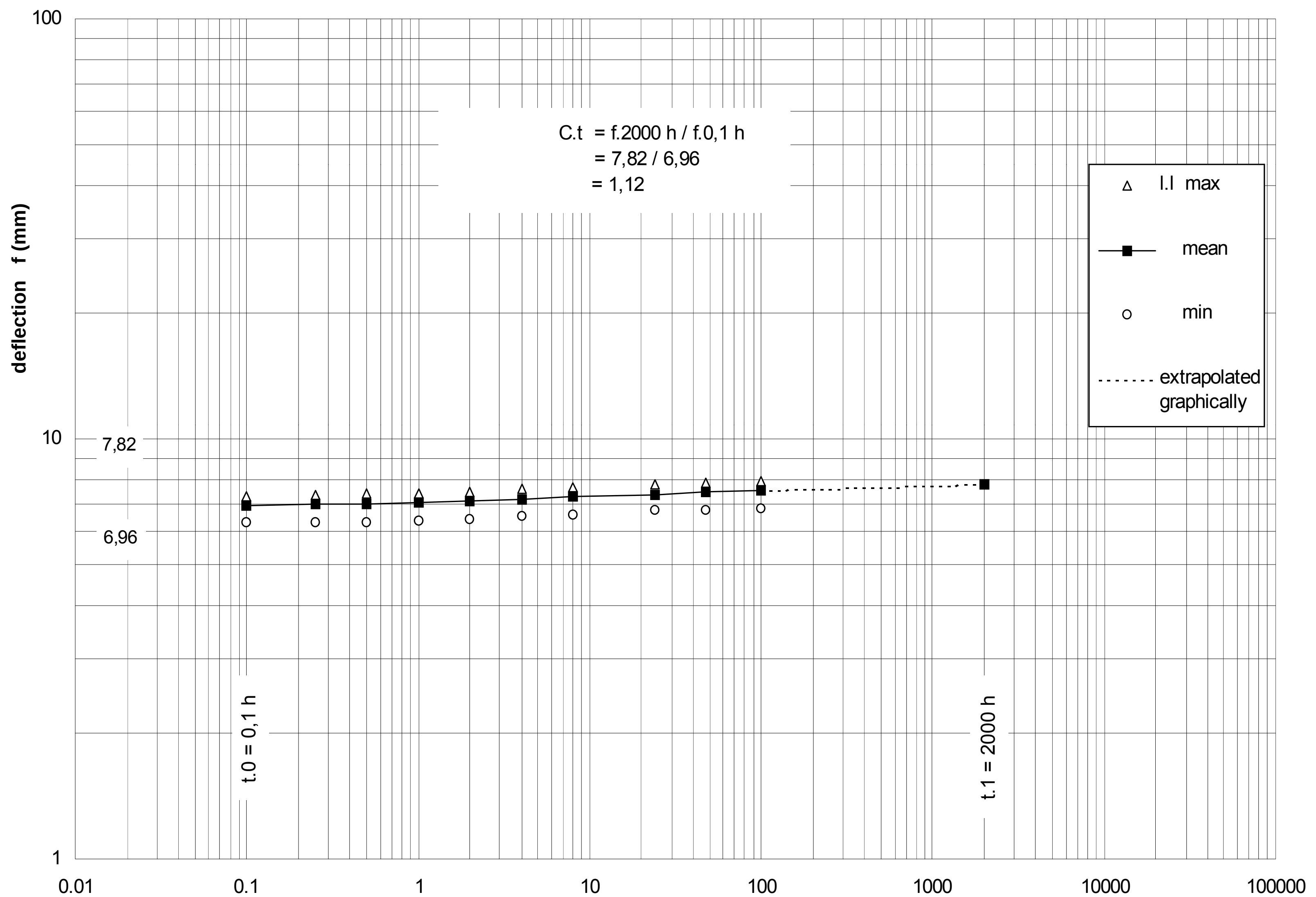


Fig H.7 Deflection (f) as a function of the load duration (t) for multi-wall PC sheet (example)

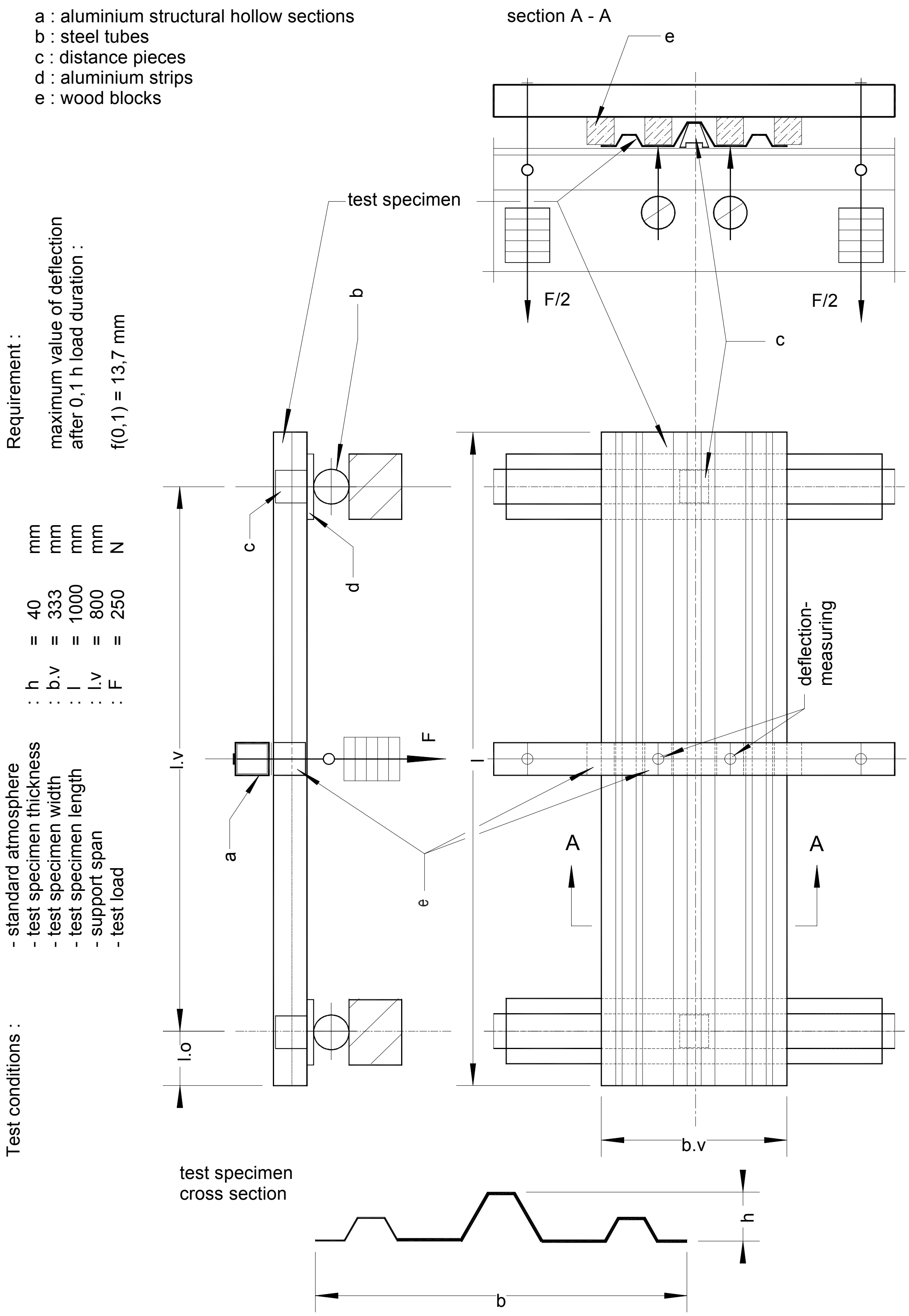


Fig H8 **Test set-up (schematic) to determine the magnification factor of the load duration of a trapezoidal profiled sheet of PVC based on EN 1993 - 1 - 2 (EUROCODE 3) (example)**

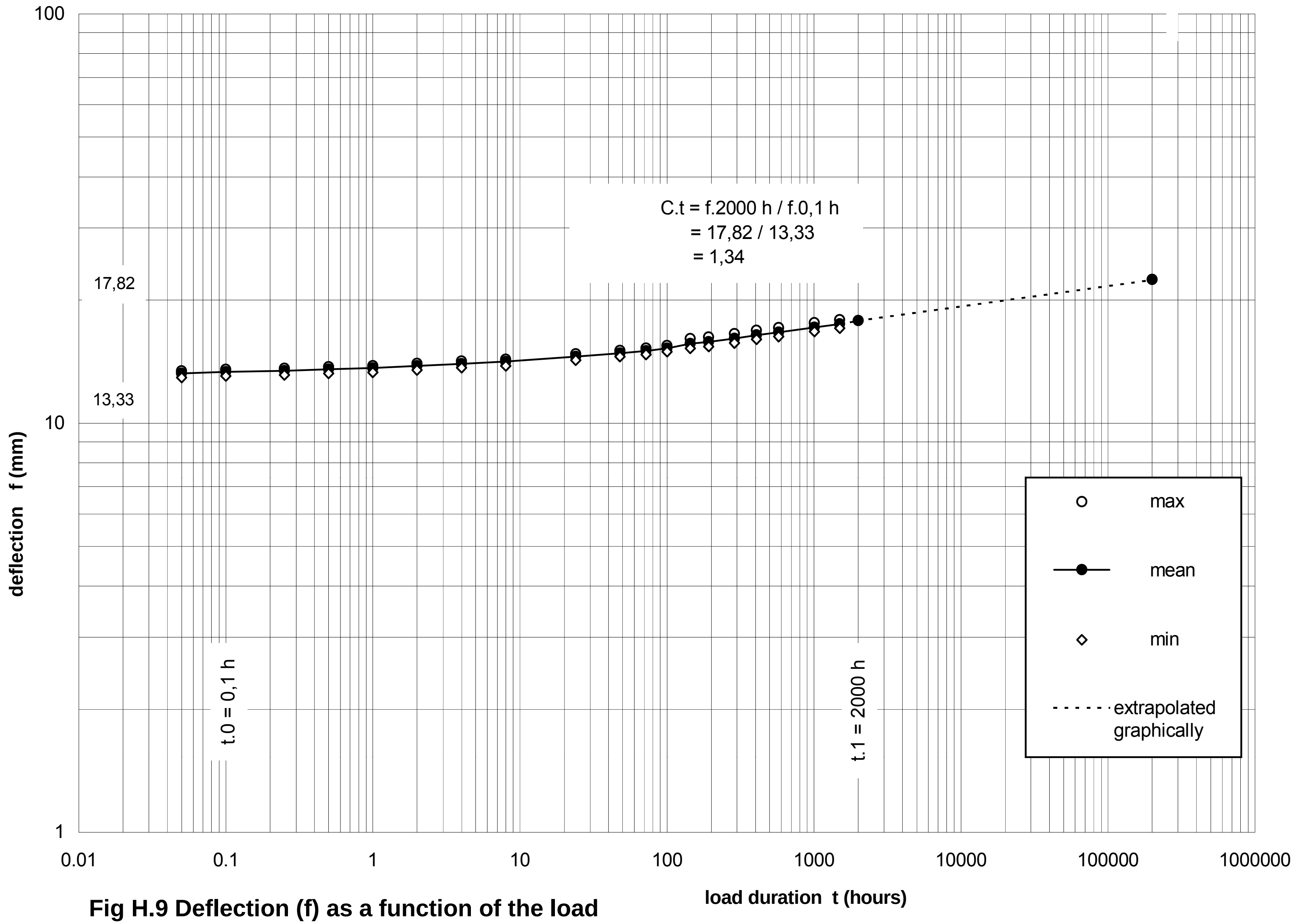
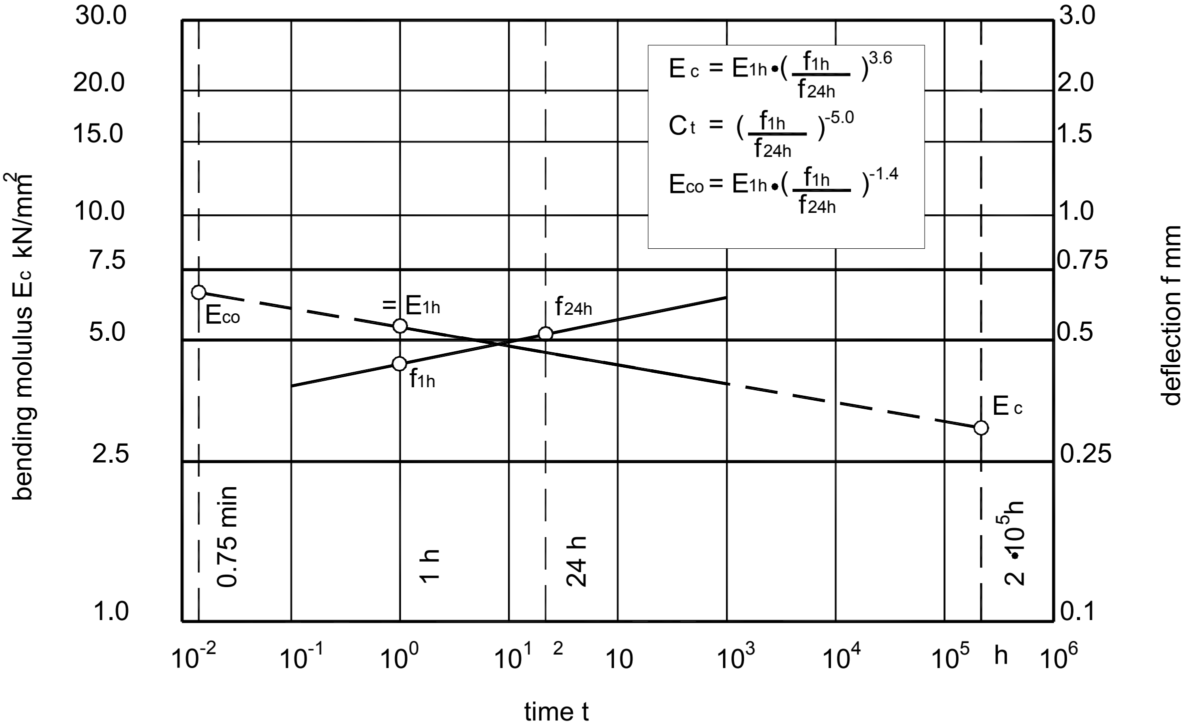


Fig H.9 Deflection (f) as a function of the load duration (t) for trapezoidal PVC sheet (example)



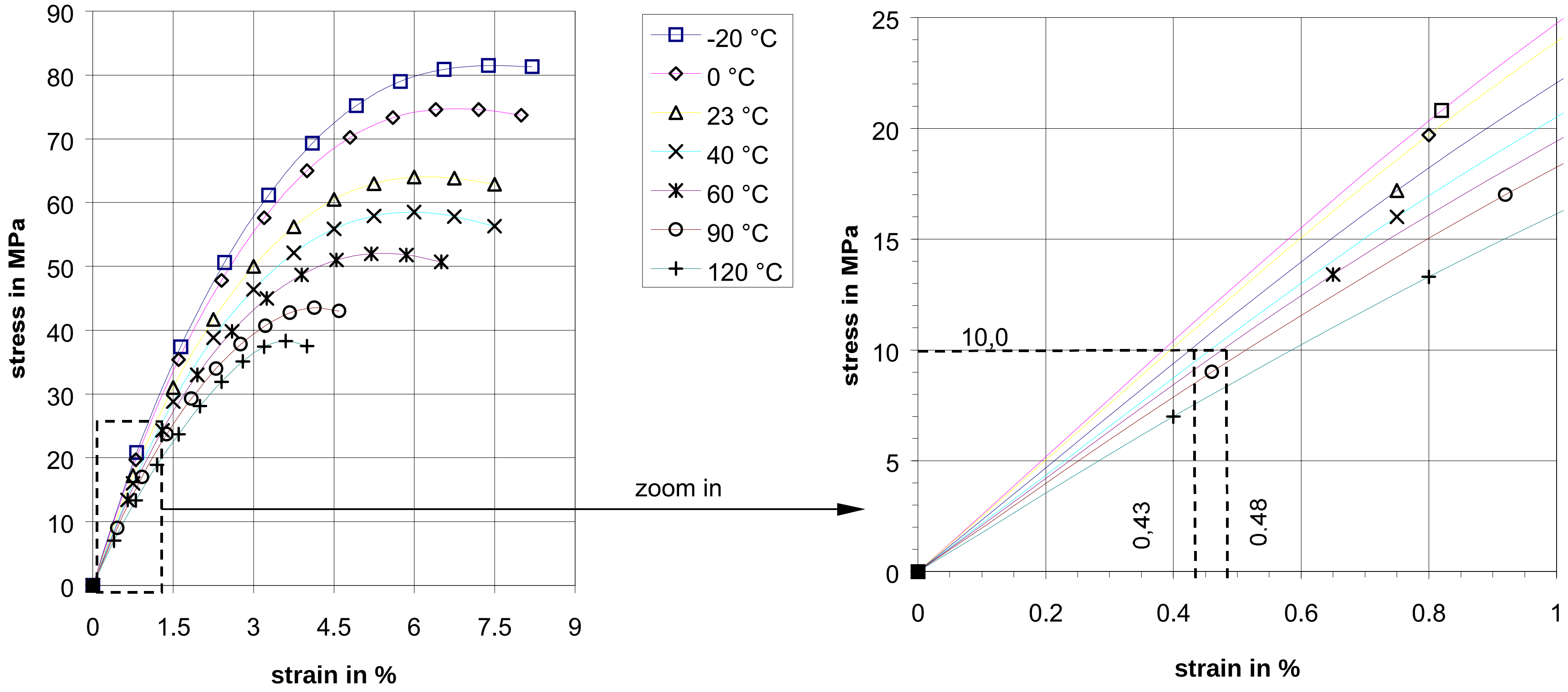
E_{1h} E - modulus, calculated on the basis of the deflection after 1h load duration

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 x 10^5 h

Fig H.10 Bending modulus behaviour of a sheet of glass fibre reinforced polyester resin (GRP) in a creep-bending test (schematic)



$$Ct = \varepsilon_{23°C} / \varepsilon_{60°C} = 0{,}48 / 0{,}43 = \underline{\mathbf{1{,}11}}$$

Fig. H.11 : Stress-strain diagram for different temperatures for the example PC

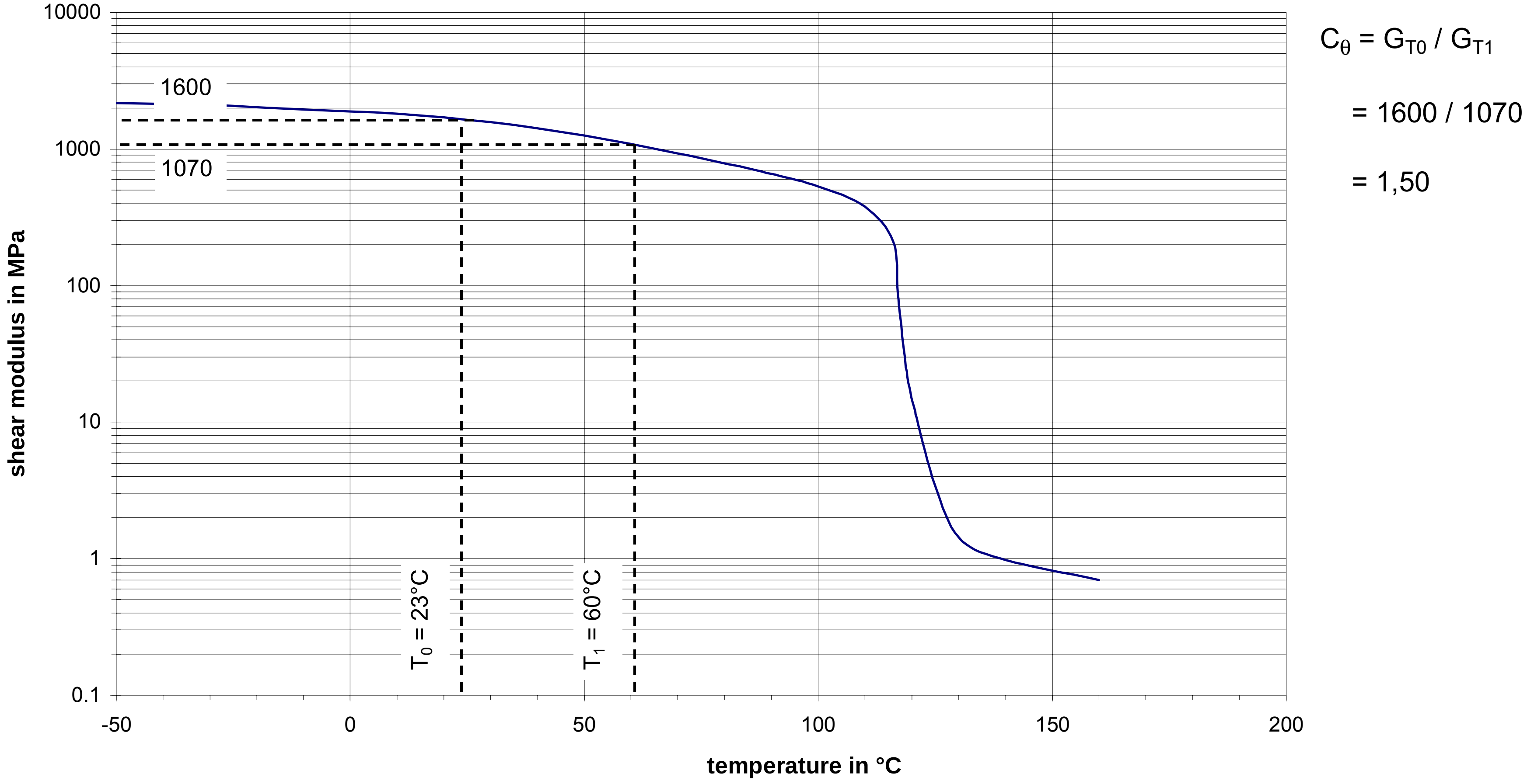


Fig. H.12 : Shear modulus as a function of temperature for PMMA (example)

Annex J - Example of factor combination

design resistance for snow loads: R_{ds} = 1,12 kN/m^2

design value of snow action: S_{ds} = 0,75 kN/m^2

design value of wind action by pressure: S_{dw} = 0,40 kN/m^2

failure mode: slipping out of the bearing profiles

Therefore, material factors C (magnification factors) are to be used:

C_{ts} = 1,2 (for snow loads)

C_{tw} = 1,0 (for wind loads);

C_u = 1,1

C_θ = 1,0 (winter)

Combined design action based on the snow loads and assessment:

$$\left(S_{ds} + S_{dw}\,\frac{C_{tw}}{C_{ts}}\right) C_u\; C_\theta = \left(0.75 + 0{,}4\,\frac{1{,}0}{1{,}2}\right) 1{,}1\; 1{,}0 = 1{,}08\;\text{ kN/m}^2 \le 1{,}12\;\text{ kN/m}^2$$

Annex K - List of Reference Documents

Mechanical Resistance and Stability

ENV 1991-1:1994	Eurocode 1 - Basis of design and actions on structures - Part 1: Basis of design
ENV 1991-2-3:1995	Eurocode 1: Basis of design and actions on structures - Part 2-3: Actions on structures - Snow loads
ENV 1991-2-4:1995	Eurocode 1: Basis of design and actions on structures - Part 2-4: Actions on structures - Wind actions
ENV 1993-1-1:1992	Eurocode 3: design of steel structures; part 1-1: general rules and rules for buildings
ENV 1993-1.3:1996	Eurocode 3: Design of steel structures - Part 1-3: General rules - Supplementary rules for cold formed thin gauge members and sheeting
ENV 1995-1-1:1993	Eurocode 5; design of timber structures; part 1-1: general rules and rules for buildings
ENV 1999-1-1:1998	Eurocode 9: Design of aluminium structures - Part 1-1: General rules - General rules and rules for buildings

Safety in Case of Fire

prEN 1187-1:1993	External fire exposure to roofs; part 1: Method of test simulating exposure to burning brands, without wind or supplementary radiant heat
prEN 1187-2:1994	External fire exposure to roofs - Part 2: Method of test simulating exposure to burning brands, with wind and supplementary radiant heat
prEN 1187-3:1998	External fire exposure to roofs - Part 3: Method of test simulating exposure to burning brands and wind
prEN ISO 1182:1998	Reaction to fire tests for building products - Non-combustibility test (ISO/DIS 1182:1998)
prEN ISO 1716:1998	Reaction to fire tests for building products - Determination of the gross calorific value (ISO/DIS 1716:1998)
prEN 13823:2000	Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item
prEN ISO 11925-2:1998	Reaction to fire tests for building products - Part 2: Ignitability when subjected to direct impingement of flame (ISO/DIS 11925-2:1998)
prEN 12101-2:1995	Smoke and heat control systems - Part 2: Specification for natural smoke and heat exhaust ventilators
prEN 12101-4	referred to in part 2 but not yet available
prEN 13501-1:2000	Fire classification of construction products and building elements; Part 1: Classification using test data from reaction to fire tests
prEN 13501-2	Classification using data from fire resistance tests, excluding ventilation services
prEN 13501-5:nya	Fire classification of construction products and building elements; Part 5 Classification using data from external fire exposure to roof tests (Note classification see RG N214 – Draft Commission Decision xx/xx/2000 implementing Council Directive 89/106/EEC as regards the classification of the external fire performance of roof coverings.)

Hygiene, Health and the Environment

EN 12114:2000	Thermal performances of buildings - Air permeability of building components and building elements - Laboratory test method
EN 1026	Windows and doors -Air permeability- Test method
EN 1027	Windows and doors -Watertightness-Test method
EN 12211	Windows and doors-Resistance to wind load-Test method

Safety in Use

EN 516:1995	Prefabricated accessories for roofing - Installations for roof access - Walkways, treads and steps
EN 517:1995	Prefabricated accessories for roofing - Roof safety hooks
EN 795:1996	Protection against falls from a height - Anchor devices - Requirements and testing

Protection Against Noise

EN ISO 140-3:1995	Acoustics - Measurement of sound insulation in buildings and of building elements - Part 3: Laboratory measurement of airborne sound insulation of building elements (ISO 140-3:1995)
EN ISO 717-1:1996	Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation (Revision of ISO 717-1:1982 and ISO 717-3:1982)

Energy Economy and Heat Retention

EN ISO 6946:1996	Building components and building elements - Thermal resistance and thermal transmittance - Calculation method (ISO 6946:1996)
EN ISO 14683:1999	Thermal bridges in building construction - Linear thermal transmittance - Simplified methods and default values (ISO 14683:1999)
EN 673:1997	Glass in building - Determination of thermal transmittance (U value) - Calculation method
EN/ISO 10211-1:1995	Thermal bridges in building construction - Heat flows and surface temperatures - Part 1: General calculation methods (ISO 10211-1-1995)
prEN/ISO 10211-2:1999	Thermal bridges in building construction - Calculation of heat flows and surface temperatures - Part 2: Linear thermal bridges (ISO/FDIS 10211-2:1999)
ISO 10456:1999	Building materials and products - Procedures for determining declared and design thermal values
EN/ISO 8990:1996	Thermal insulation - Determination of steady-state thermal transmission properties - Calibrated and guarded hot box (ISO 8990:1994)
prEN 12664:2000	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 674:1997	Glass in building - Determination of thermal transmittance (U value) - Guarded hot plate method
EN 675:1997	Glass in building - Determination of thermal transmittance (U value) - Heat flow meter method
prEN ISO 13788:2000	Hygrothermal performance of building components and building elements - Internal surface temperature to avoid critical surface humidity and interstitial condensation - Calculation method (ISO/FDIS 13788:2000)
prEN ISO 12572:2000	Hygrothermal performance of building materials and products - Determination of water vapour transmission properties (ISO/FDIS 12572:2000)
prEN 12412-2:1997	Windows, doors and shutters - Determination of thermal transmittance by hot box method - Part 2: Frames
prEN ISO 10077-2:1998	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames (ISO/DIS 10077-2:1998)

EN 410:1998	Glass in building. Determination of luminous and solar characteristics of glazing

Moon P, J Franklin Inst., 230, 583 (1940) 'Proposed Standard Solar Radiation Curves for Engineering Use'

Thekaekara M P, Solar Energy, 9, 7 (1965) ‘The solar Constant and Spectral Distribution of Solar Radiant Flux’.

Various

Materials/components

EN 1013-1:1997	Light transmitting profiled plastic sheeting for single skin roofing - Part 1: General requirements and test methods
EN 1013-2:1998	Light transmitting profiled plastic sheeting for single skin roofing - Part 2: Specific requirements and test methods for sheets of glass fibre reinforced polyester resin (GRP)
EN 1013-3:1997	Light transmitting profiled plastic sheeting for single skin roofing - Part 3: Specific requirements and test methods for sheets of polyvinyl chloride (PVC)
EN 1013-4:2000	Light transmitting profiled plastic sheeting for single skin roofing - Part 4: Specific requirements, test methods and performance of polycarbonate (PC) sheets
EN 1013-5:2000	Light transmitting profiled plastic sheeting for single skin roofing - Part 5: Specific requirements, test methods and performance of (poly) methylmethacrylate (PMMA) sheets
EN 10088-1:1995	Stainless steels - Part 1: List of stainless steels
prEN 12206-1:1995	Paints and varnishes - Coating of aluminium and aluminium alloys for architectural purposes - Part 1: Coatings prepared from powder coating materials
prEN 12206-2:1995	Paints and varnishes - Coating of aluminium and aluminium alloys for architectural purposes – Part 2 : Coatings prepared from liquid organic coating materials
prEN 12608:1996	Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows - Classification, requirements and test methods
	UEAtc Technical Report for the Assessment of Windows in Coloured PVC-U (1995)
prEN XXXX (11/98)	
CEN TC128	Roof Coverings. Continuous rooflights with upstands
EN 607:1995	Eaves gutters and fittings made of PVC-U - Definitions, requirements and testing
EN 612:1996	Eaves gutters and rainwater down-pipes of metal sheet - Definitions, classifications and requirements
EN 1462:1997	Brackets for eaves gutters - Requirements and testing
PrEN12200-1	Plastics rainwater piping systems for external use – Unplasticised poly (vinyl chloride) (PVC – U) Part 1: Requirements for pipes, fittings and the system.
EN ISO 12944	Paints and varnishes. Corrosion protection of steel structures by protective paint systems.
EN ISO 14713:1999	Protection of iron and steel in structures. Zinc and aluminium coatings

General test methods

EN 60:1977	Glass reinforced plastics; Determination of the loss on ignition
EN 63:1977	Glass reinforced plastics; Determination of flexural properties; Three point method
EN ISO 178:1996	Plastics - Determination of flexural properties (ISO 178:1993)
EN ISO 291:1997	Plastics - Standard atmospheres for conditioning and testing (ISO 291:1997)
EN ISO 527-1:1996	Plastics - Determination of tensile properties - Part 1: General principles (ISO 527-1:1993 including Corr 1:1994)
EN ISO 527-2:1996	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:1993 including Corr 1:1994)
EN ISO 899-2:1996	Plastics - Determination of creep behaviour - Part 2: Flexural creep by three-point loading (ISO 899-2:1993)
ISO/DIS 3934:1998	Rubber, vulcanized and thermoplastic - Preformed gaskets used in buildings - Classification, specifications for materials and test methods for gaskets (Revision of ISO 3934:1978 and ISO 5892:1981)
ISO 4892-1:1999	Plastics - Methods of exposure to laboratory light sources - Part 1: General guidance
ISO 4892-2:1994	Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc sources
EN ISO 6603-1:2000	Plastics - Determination of puncture impact behaviour of rigid plastics - Part 1: Non-instrumented impact testing (ISO 6603-1:2000)
ISO 9050:1990	Glass in building; determination of light transmittance, solar direct transmittance, total solar energy transmittance and ultraviolet transmittance, and related glazing factors
EN ISO 12017:1996	Plastics - Poly(methyl methacrylate) double- and triple-skin sheets - Test methods (ISO 12017:1995)
ISO 13468-1:1996	Plastics - Determination of the total luminous transmittance of transparent materials - Part 1: Single-beam instrument
ISO 6988:1985	Metallic and other non organic coatings; Sulfur dioxide test with general condensation of moisture
DIN 50 018:1997	Testing in a saturated atmosphere in the presence of sulfur dioxide

Quality Management

EN ISO 9002:1994	Quality systems - Model for quality assurance in production, installation and servicing (ISO 9002:1994
EN 29002:1988	Quality systems; Model for quality assurance in production and installation
EN ISO 9001: 2000	Quality management systems. Requirements.