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GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL

OF

NON LOAD-BEARING PERMANENT SHUTTERING KITS/SYSTEMS BASED ON HOLLOW BLOCKS OR PANELS OF INSULATING MATERIALS AND SOMETIMES CONCRETE

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FOREWORD

BACKGROUND OF THE ETA GUIDELINE

This Guideline has been drawn up by the EOTA Working Group 03.05/05 - Non load-bearing permanent shuttering kits/systems based on hollow blocks or panels of insulating materials and, sometimes, concrete.

The WG consisted of members from nine EU-countries (Austria, Belgium, Finland, France, Germany, Italy, Portugal, Sweden and the United Kingdom).

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. Consideration is given to ETAG 003 " Internal Partition kits for use as non load-bearing walls " and to ETAG 004 " External Thermal insulation composite systems with rendering ".

The general assessment approach of the Guideline is based on relevant existing knowledge and testing experience.

As most member countries and the Interpretative Document on SAFETY IN CASE OF FIRE use classes to define fire resistance and reaction to fire, so too does the Guideline. Otherwise, classes are not used throughout the Guideline. All product characteristics are, in general, expressed as numerical values. This approach is in accordance with the philosophy of the CPD that The Essential Requirements deal with the building works and an ETA is a favourable technical assessment of a construction product for an intended use, i.e. for the use it gets when incorporated in the works. The ETA deals only with the product and states classes or product characteristics to be used subsequently by the designer of the works.

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 D. 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	: 25/06/97
- the final mandate issued by the EFTA	: 25/06/97
- 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	: 28/05/2002

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

No existing ETAG is superseded

1.2 STATUS OF ETAG

1.2.1 **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 that the approved shuttering kits are fit for their intended use, i.e. that 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.

1.2.2 **This ETAG is a basis for ETA's, i.e. a basis for technical assessment of the fitness for use of a shuttering kit for an intended use. An ETA-Guideline is not in itself a technical specification in the sense of the CPD.**
This ETAG expresses the common understanding of the approved bodies, acting together within EOTA, as to the provisions of the Construction Products Directive and of the Interpretative Documents in relation to the shuttering kits and uses concerned, and is written within the framework of a mandate given by the Commission and the EFTA secretariat after consulting the Standing Committee for Construction.

1.2.3 When accepted by the European Commission after consultation with the Standing Committee for Construction this **ETAG is binding** for the issuing of ETAs for the shuttering 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 (product) 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 harmonized European standard which is the direct basis for attestation of conformity.

Where appropriate, shuttering 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 art permits and after having been confirmed as appropriate for the particular product by the ETA.

2. SCOPE AND TYPES

2.1 SCOPE

This ETA guideline deals with non load-bearing permanent shuttering kits/systems based on hollow blocks or panels of thermal insulating material and, sometimes, concrete for construction of external walls, internal walls above or below ground, and partitions, for buildings.

For the purposes of this ETAG the kit is considered to be shuttering components used to contain fresh concrete during the construction of walls. The assembled system is the kit installed as part of the wall and, if specified, any incorporated finish. The performance requirements of the internal core (reinforced or un-reinforced concrete) are not the subject of this ETAG.

The following materials can be incorporated in the hollow blocks or panels: concrete, expanded polystyrene aggregates concrete, autoclaved aerated concrete, gypsum, clay, metal, plastic insulation, foamed glass, organic fibres, inorganic fibres, wood, cement bonded wood-wool, mineral bonded wood-wool, mineral bonded wood-chips, expanded cork. After assembling, the blocks or panels are filled in situ with concrete, with or without reinforcement. The complete wall can be load-bearing (structural) or non load-bearing (non structural).

Common finishes to the walls such a rendering, cladding, plastering or dry-lining are normally not part of the kit. Nevertheless, some of these products (rendering, plastering) can be part of the kit or can be referenced by the ETA applicant. In both cases they are subject of this evaluation.

The shuttering kits are installed in accordance with the ETA applicant design and installation instructions. Components are factory-produced as part of the kit either by the ETA applicant himself or by other manufacturers with agreement of the ETA applicant. They are assembled on site before being filled with concrete and then incorporated as a part of the work.

These shuttering kits generally comprise hand-installed elements with at least two shuttering leaves linked by spacers providing resistance to the tensile loading induced by pouring fresh concrete.

The shuttering leaves or at least one of them are designed to provide the main part of the insulation performance of the wall but does not contribute to its load-bearing capacity. They can be made of a combination of various materials but at least one shuttering leaf shall incorporate insulation material; they may also incorporate various profiles (metallic, plastic, ...). To complete the kit, e.g. for internal walls, some shuttering elements may not incorporate insulating material.

Spacers, which can be manufactured intrinsically with the shuttering leaves (same material) can also be made of other materials.

The main design considerations are the percentage and the directions of the voids to be filled with concrete. In this respect, different types of systems can be distinguished between those providing an almost continuous concrete infill to those providing only a grid of concrete infilled voids.

2.2 TYPES

The following types are used to identify the field of application and establish the product performance characteristics to be addressed. Regardless of classification all the shuttering kits shall be submitted to the same methods of assessment.

The ETA applicant will choose which properties will be assessed and declared in the ETA. The choice will depend on the intended use of the wall the ETA applicant wants to cover (intended market, accounting for national variations). A specific kit may not cover all the following intended uses.

Types according to intended use :

Load-bearing (structural) walls : walls which ensure the stability of a structure by transferring vertical loads (generally applied from a floor or a roof) and/or horizontal loads applied in the wall plane by a floor or a roof, and possibly lateral loads.

Non load-bearing (non structural) walls : walls which do not ensure the stability of a structure but which transfer to this structure their own weight (self-bearing wall) and, possibly, wind-loading perpendicular to their plane.

Internal walls : structural or non structural walls intended to separate identical or different internal environments ; partition walls are internal walls.

External walls : structural or non structural walls which are intended to separate an internal environment from a changing external environment ; external walls, also known as " façade walls " have to protect the internal environment from weather effects.

Types according to concrete infill structural pattern :

1. Continuous type :
The structural pattern of the continuous type is a concrete wall, which is only perforated by spacers at points. The spacers are generally regularly arranged. The sum of the cross-sectional areas of the spacers is only a few percent of the area of the wall.

2. Grid type :
The structural pattern of the grid type consists of concrete columns connected by horizontal concrete ribs. Columns and ribs are formed by filling the voids of the shuttering hollow blocks or panels with concrete. The vertical columns extend the entire height of the wall without interruption or reduction of cross-sectional area.

3. Column type :
The structural pattern of the column type consists of regularly arranged concrete columns without concrete beams or with concrete beams not structurally connected to them. Columns are formed by filling the vertical voids of hollow blocks or panels with concrete. The vertical columns extend to the entire height of the wall without interruption or reduction of cross-sectional area.

4. Other types :
All types which are not defined above.

Types according to basic elements of the shuttering :

Hollow blocks :
Shuttering elements, the dimensions of which are more or less similar to those of shuttering concrete blocks without incorporation of insulating material, made either by manufacturing monolithic units or by assembling on site leaves and spacers.

Panels :
Pre-assembled shuttering elements generally of one storey height.

2.3 ASSUMPTIONS

The ETAG deals with shuttering kits intended for the construction of buildings in concrete, reinforced or not.

Additional requirements not addressed in this ETAG may be necessary for special uses (cold chambers, industrial applications,....).

With regard to finishes which are not incorporated in the kit (rendering, cladding, plastering etc…) the ETAG only considers their possible influence on the overall performance of the permanent shuttering, not the performance of the finish itself.

The state of the Art doesn't 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 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 which 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-Format-Comprehension document.

3. TERMINOLOGY

3.1 COMMON TERMINOLOGY AND ABBREVIATIONS (SEE ANNEX A)

3.2 TERMINOLOGY AND ABBREVIATIONS SPECIFIC TO THIS ETAG

Autoclaved aerated concrete (AAC) :
AAC is made of hydraulics binders such as cement and/or lime combined with fine siliceous based material, cell-generating material and water. The raw materials are mixed together and cast into moulds where the mix is allowed to rise and set into cakes. After this part of the process, the cake is cut into the required sizes of units and cured with high pressure steam in autoclaves.

Component :
A component is a single part of the shuttering kit or for the purposes of testing a configuration of some parts of the shuttering kit.

ETICS :
External thermal insulation composite systems with rendering (see ETAG 004).

End use conditions :
End use conditions are specific testing configurations, specified by the manufacturer and accepted by the approval body. Generally end use conditions are an assembled shuttering kit filled with concrete, after hardening of the concrete. It includes incorporated manufactured finishes. If required by the ETA applicant, the shuttering kit may be combined with different applied finishes referred to by precise specification or by types classification (cladding, rendering, plastering,…) which are taken into account in end use conditions.

Expanded Polystyrene Aggregates Concrete :
Concrete with expanded polystyrene particles as aggregates. Expanded polystyrene aggregates concrete may additionally contain fine aggregates, admixtures and other additions. The mix proportions shall be such that the surfaces of all polystyrene particles are totally covered by hardened cement paste.

Incorporated finish :
Wall finish which is put on the market and installed on building site as an exposed part of the shuttering kit.

IPS :
Internal partition kit (see ETAG 003)

Lightweight concrete :
Concrete having a closed structure and an oven dry density of not less than 800 kg/m^3 and no more than 2100 kg/m^3, made entirely or partly with lightweight aggregates with a porous structure and a particle density of less than 2000 kg/m^3.

Non-load bearing shuttering :
Shuttering which has no significant mechanical resistance or the mechanical resistance of which is not taken into account for dimensioning the wall to carry loads.

Normal weight concrete :
Concrete having an oven-dry density greater than 2100 kg/m^3, but not exceeding 2600 kg/m^3.

Resulting structural pattern :
The shuttering, filled with concrete, creates a structural concrete formation the geometry of which is defined as the structural pattern. The structural concrete formation may be reinforced or not.

Shuttering kit :
Non load-bearing shuttering assembly based on hollow blocks or panels incorporating insulating materials, filled on site with concrete and remaining as a permanent part of the wall.

Spacers :
Devices incorporated in the shuttering, either in the factory or on site, to connect the shuttering leaves and resist the pressure of the concrete during filling and until hardening. They can be made with the same material as shuttering leaves or with specific materials, metallic or plastic for instance.

Thermal insulation of a shuttering kit :
Considering the large range of applications (type of buildings and climate conditions) a numerical limit for the thermal insulation required for a permanent shuttering can only be set when the specific application is defined. Nevertheless the thermal conductivity (λ value) of the incorporated insulating material should not exceed 0,5 W / m.K.

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

GENERAL NOTES

a) Applicability of the ETAG

This ETAG provides guidance on the assessment of shuttering kits and their intended uses. It is the manufacturer or producer who defines the shuttering 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 shuttering kits, which are fairly conventional, only some of the tests and corresponding criteria are sufficient to establish fitness for use. In other cases, e. g. special or innovative shuttering 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 this section

The assessment of the fitness of the shuttering kits 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 shuttering kits and uses concerned, beginning with the Essential Requirements for works (CPD art. 11.2) and then listing the corresponding relevant characteristics of products.
- 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 shuttering kits.
- Chapter 7, **assumptions and recommendations** are only relevant in as far as they concern the basis upon which the assessment of the shuttering kits is made concerning their fitness for the intended use.

c) Levels or classes or minimum requirements, related to the essential requirements and to the shuttering kit 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 shuttering 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 shuttering kit doesn’t any longer fall under the scope of 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 shuttering kit for the intended use of 50 years, provided that the product is subject to appropriate use and maintenance (cf. 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 shuttering 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 shuttering kits in relation to the expected, economically reasonable working life of the works (based upon ID. par. 5.2.2).

e) Fitness for the intended use

According to the CPD it has to be understood that within the terms of this ETAG, shuttering kits 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 shuttering kits shall be suitable for use in construction works which (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 shall, subject to normal maintenance, be satisfied for an economically reasonable working life. The requirements generally concern actions which are foreseeable (CPD Annex I, preamble).

4. REQUIREMENTS

This chapter sets out the aspects of performance to be examined in order to satisfy the relevant Essential Requirements for shuttering kits, 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 (product 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 or property 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 the assessing and judging under another Essential Requirement. Similarly, characteristics or properties which have a bearing on durability assessments may be dealt with under ER 1 to ER 6, 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 product. (cfr ETA-format par. II.2).

Each Essential Requirement is considered in turn.

Table 1 presents an overview of the Essential Requirements, the relevant paragraphs of the corresponding Interpretative Documents, the product characteristics given in the mandate and the performance characteristics in the ETAG with the corresponding paragraphs.

Table 1 : Relationship between ID paragraph for works, ID paragraph for product performance, product characteristics in the mandate and product performance in the ETAG with corresponding paragraphs

E.R.	Corresponding ID paragraph for works	Corresponding ID paragraph for product performance	Product Characteristics of Annex 2 of the Mandate	Performance Characteristics in the ETAG	ETAG paragraph
1	4.2 Provisions concerning works of part of them	4.3 Provisions concerning products	Resulting structural pattern;	Resulting structural pattern	4.1.1.
			Efficiency of filling (The shuttering system must allow the erection of safe concrete walls, free from concrete voids, with sufficiently low loss of water and not favouring segregation)	Efficiency of filling	4.1.2.
			Possibility of reinforcement (The shuttering must permit a possibility for steel reinforcement)	Possibility of steel reinforcement	4.1.3.
2	4.2.2.2.a Load-bearing capacity of walls with and without fire-separating function	4.3.1.3.2 and 3 Load-bearing elements/concrete infill	Reaction to fire (in end use conditions) (for shuttering systems/kits for walls subject to fire regulations)	Reaction to fire	4.2.1.
	4.2.3.3.2.a Limitation of the generation and spread of fire and smoke within the room of origin 4.2.3.4.2 a and b Limitation of spread of fire and smoke within the room of origin : Exposed surfaces and walls Limitation of spread of fire to neighbouring construction works : fire separating walls, external walls and façades.	4.2.3.1.1. Products subject to reaction to fire requirements-wall 4.3.1.3.5.2 a and b Façades/external walls - fire propagation aspects 4.3.1.1 Products subject to reaction to fire requirements - façades/external walls	Resistance to fire (in end use conditions) (for shuttering systems/kits for walls subject to fire regulations)	Resistance to fire of the wall : E, I, R, M, W	4.2.2.
3	3.3.1 Indoor environment	3.3.1.1.3.2.a Emission and release of pollutants	Dangerous substances	Dangerous substances	4.3.1
	3.3.1.1 Air quality 3.3.1.2 Dampness	3.3.1.2.3.2. e1 Dampness control : walls, walling materials	Water vapour permeability Water absorption	Water vapour permeability Water absorption. Capillarity of the shuttering faces	4.3.2. 4.3.3.
	4.4.5	3.3.5.3	Water tightness	Watertightness of finishes	4.3.4.

E.R	Corresponding ID paragraph for works	Corresponding ID paragraph for product performance	Product Characteristics of Annex 2 of the Mandate	Performance Characteristics in the ETAG	ETAG paragraph
4	3.3.2.1 Direct impacts : - impacts of falling objects, fixed or forming part of the work, upon users - impact/collisions between users and part of the work as result of accidents	3.3.2.3 Mechanical resistance and stability Definition of geometry	Bond strength of composites (blocks and panels)	Bond strength and resistance to impact loads	4.4.1.
			Resistance to filling pressure (The resistance to filling pressure refers to the adequate behaviour of the shuttering elements (stability, internal pressure, …) when concrete acts upon them while being poured into)	Bending, shear strength of the shuttering faces Resistance and anchoring of the spacers Stability of the shuttering	4.4.2.
	3.3.2.2 Geometry : - presence of sharp or cutting edges - nature of surfaces			Safety against personal injuries by contact	4.4.3
5	4.2.1 Provisions concerning walls - insulation for noise from outside - insulation for noise from another space - transmission of impact noise	4.3.2.1 – 4.3.4.1 Acoustic properties of products	Airborne sound insulation(In end use conditions)	Airborne sound insulation	4.5.1.
			Sound absorption	Sound absorption	4.5.2.
6	4.2 Energy consumption limitation	4.3.2.1 Fabric materials Table 4.1 Characteristics 4.3.2.2 Fabric components Table 4.2 Component Characteristics	Thermal resistance	Thermal resistance Influence of moisture Transfer on insulating capacity of the wall Thermal inertia	4.6.1. 4.6.2 4.6.3
D	Aspects of durability and serviceability				
			Relevant factors of deterioration such as freeze-thaw	Resistance to deterioration Résistance to normal use damage	4.7.1 4.7.2

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 loading that are liable to act on it during its construction and use will not lead to any of the following :

- *collapse of the whole or part of the work;*
- *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*

The following aspects of performance are relevant to this Essential Requirement for permanent shuttering kits/systems.

4.1.1. Resulting structural pattern

The geometry of the voids within the shuttering shall be such as to ensure that the resulting concrete wall can be designed and constructed to satisfy the relevant parts of this Essential Requirement in accordance with laws, regulations and administrative provisions. Resulting structural pattern governs the design methods applicable for the location where the product is incorporated into the works.

Resulting verticality of the filled concrete wall governs the structural members behaviour and the overall resistance of the structure. Any defects influence the general stability.

It is possible to differentiate 4 types of structural patterns as defined in chapter 2.2: continuous type, grid type, column type and other types.

These types are governed by shape and dimensions of the blocks, leaves and spacers, panels, when stacked correctly on site.

4.1.2 Efficiency of filling

The shuttering system shall allow the erection of safe concrete walls, free from significant voids, with sufficiently low loss of water between joints or through the shuttering faces and not promote segregation

In this respect it shall be possible to properly fill the shuttering and compact the concrete, if necessary, according to the installation procedure given by the ETA applicant. In particular the shuttering shall be sufficiently closely fitting to avoid dispersion of the concrete fines and sufficiently strong to prevent damage by concrete filling.

4.1.3 Possibility of steel reinforcement

The geometry of the voids and the arrangement of the spacers should be compatible with correct installation and provide appropriate covering of the reinforcement.

Some minimum reinforcing of the concrete in-fill should be practicable.

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 permanent shuttering kits/systems.

4.2.1 Reaction to fire

Requirements for the reaction to fire shall be in accordance with laws, regulations and administrative provisions applicable to the end use of the wall. The corresponding performances shall be specified via the CEN classification documents.

4.2.2 Resistance to fire

Requirements for the resistance to fire of the wall shall be in accordance with laws, regulations and administrative provisions, applicable to the end use of the wall. The corresponding performances shall be specified via the CEN classification documents.

4.3 HYGIENE, HEALTH AND ENVIRONMENT:

The Essential Requirement laid down in the COUNCIL DIRECTIVE 89/106/EEC is as follows :
The construction work 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 permanent shuttering kits :

4.3.1 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 Water vapour permeability

The shuttering kit shall be designed and installed in such a way that moisture transfer through the wall does not cause water vapour to condense within the wall or on its surface to an extent that would adversely affect the properties of the wall.

4.3.3 Water absorption

The shuttering kit shall be designed and installed in such a way that the shuttering leaves do not generate water suction on the fresh concrete that would adversely affect the quality of the hardened concrete. For the parts of the kit which are directly exposed to water, the amount of water absorption shall be sufficiently limited to not affect the properties of the wall. It shall too not induce corrosion of metallic spacers and/or reinforcement.

The aspects of this requirement are in relation to clause 4.1.2 in respect of water suction from the fresh concrete by action of capillarity and to clause 4.3.4 in respect of moisture from the ground etc…

4.3.4 Watertightness

Requirements regarding the watertightness of walls are relevant only where walls are used in environments where they are exposed directly to external water (e.g. rain or snow or water from the ground) or internal water (e.g. in bathrooms, washrooms) and when there are risks of harmful water accumulation or condensation. In most cases such requirements relate mainly to the performance of the finishes or moisture proofing. The aim is to prevent the penetration of rain or snow or moisture from the ground to the inside of the building.

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 permanent shuttering:

4.4.1 Bond strength and resistance to impact load

The shuttering facings shall be stable under the loads due to intrinsic weight, wind pressure and suction as well as under the impact loads when subject to normal use and normal traffic.

Weight of finishes
The shuttering kit shall support the weight of the incorporated or applied finishes without harmful deformation.

Effects of wind actions
The shuttering kit shall have sufficient mechanical resistance to the forces of pressure, suction and vibration due to wind.

Impact loads due to normal use
The shuttering kit shall be designed such that in end use conditions, the effect of impact loads caused by normal use and normal traffic does not compromise the stability and the integrity of the shuttering.

The bonding between outer part of the shuttering kit and inner concrete structure shall carry, without damage or unacceptable deformation, the leaning on standard maintenance equipment such as a ladder.

4.4.2 Resistance to filling pressure.

The shuttering kit shall withstand the pressure of the fresh concrete, when poured in and possibly compacted within the limits specified by the ETA holder.
The resistance to filling pressure refers to the required behaviour of the shuttering elements (stability, internal pressure,...) when subjected to the pouring of fresh concrete

4.4.3 Safety against personal injuries by contact

Shuttering kits with incorporated finishes shall be designed and installed with due consideration to safety of occupants under normal conditions or where a person accidentally falls against the wall. The characteristics of the shuttering kit affecting the level of risk include :

- Existence of sharp or cutting edges, particularly in the possible joints between finishes, components and in opening frames possibly combined with the kit
- Nature of surfaces (e.g. risk of abrasion on rough surfaces) and texture.

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.

The following aspects of performance are relevant to this Essential Requirement for permanent shuttering :

4.5.1. Airborne Sound Insulation.

Transmission of airborne sound across a permanent shuttering wall shall be reduced in accordance with laws, regulations and administrative provisions, applicable for the location where the shuttering

kit is incorporated in the works.

Any requirements relating to the walls used in a flanking position, or with attached structures, or stagger walls shall be determined for their effects on the requirements set out above.

4.5.2 Sound Absorption

Sound absorption will not normally be considered for these products when additional internal surface finishes are applied to them. Sound absorption shall only be considered for a shuttering kit with a factory-made finish.

The acoustic qualities of the surface of the shuttering shall meet any relevant requirements with respect to reverberation time.

4.6 ENERGY ECONOMY AND HEAT RETENTION

The Essential Requirement laid down in the Council Directive 89/106/EEC is a 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 occupants.

The following aspects of performance are relevant to this Essential Requirement for permanent shuttering insulating walls :

When used between spaces with different hygrothermal conditions, permanent shuttering walls shall have adequate thermal insulating properties to :

– limit energy consumption,

– prevent discomfort caused by radiation or convection (draught),

– prevent water vapour condensing within the wall or on its surface.

4.6.1 Thermal resistance

The thermal transmittance/resistance of the permanent shuttering wall shall be established in accordance with the laws, regulations and administrative provisions applicable for the location where the product is incorporated in the works.

The effect of thermal bridges shall be considered

4.6.2 Influence of moisture transfer on insulating capacity of the wall

The permanent shuttering insulating kit shall be designed and installed so that the position and extent of any moisture condensation will not have a significant adverse effect on the insulating capability of the completed wall.

4.6.3 Thermal inertia

The influence of the shuttering kit arrangement on the thermal inertia of walls, both internal and external, shall be established in cases where this characteristic is required to determine the energy consumption of the works (for heating and/or for cooling).

4.7 ASPECTS OF DURABILITY AND SERVICEABILITY

The following requirements relate to the Essential Requirements, but not to any individual Essential Requirement. As a consequence, failure to meet these requirements may result in one or more of the Essential Requirements no longer being met.

4.7.1 Resistance to deterioration

All components of the shuttering kit shall retain their properties during the overall service life of the assembled system under normal conditions of use and maintenance such that the assembled system quality is maintained. This requires the following :

- All components shall display a reasonably predictable chemical-physical stability. Where reactions between materials in contact occur, they should take place slowly.
- All materials shall be either naturally resistant to, or protected against corrosion or biological

degradation.

- All materials shall be compatible with each other.

The deterioration agents include:

4.7.1.1 Physical agents

The external shuttering leaves and the spacers, shall not be adversely affected (e.g. deterioration, deformation, corrosion) by physical agents, e.g. freeze-thaw, moisture, temperature and solar radiation, nor movements of the concrete structure. Low air temperatures of the order of - 20°C and high air temperatures of + 50°C are generally regarded as the extremes in temperature change. In northern European countries however, the temperatures of the air can decrease to - 40°C. Solar radiation increases the surface temperatures of the external finish when exposed. The increase depends on the radiation flow and the energy absorption of the surface (colour). It is generally considered that the maximum surface temperature of any finish is + 80°C.
Neither low nor high temperatures occurring in the external finish shall produce a destructive or irreversibly deforming effect on the shuttering.
Changes in the surface temperatures shall not cause any damage (e.g. change of mean external temperature between summer and winter, a sudden change due to prolonged exposure to solar radiation followed by intensive rain, or the change of temperature between sun and shade).
The internal shuttering leaves shall not be adversely affected by localised heat from heating panels or radiators located next to the shuttering.
The bonding resistance of the shuttering kit shall not be compromised by stresses induced by normal movements of the concrete structure : concrete shrinkage and creep and/or movements due to variations in the stresses applied to the structure.

4.7.1.2 Chemical agents

Water, carbon dioxide, oxygen (possible corrosion) and other normal chemical hazards likely to come into contact with the permanent shuttering kit for example, cleaning materials used on an incorporated finish, shall not have an adverse effect.

4.7.1.3 Biological agents

The shuttering kit shall not be affected adversely by fungi, bacteria, algae and insects.
The shuttering kit shall be designed to avoid infestation of the wall by insects or vermin.

4.7.2 Resistance to normal use damages

As far as incorporated finishes or supports for applied finishes are not made of conventional materials (e.g. brittle materials), there is a risk of functional damage of the shuttering kit in use when fixing objects or incorporating ducts into it, or simply under normal use impact. So the statements of the installation guide in this respect (see 7.2.6 and 7.2.7) shall be assessed.

5. METHODS OF VERIFICATION OF THE PERFORMANCE CHARACTERISTICS

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.). The possibility exists to use existing data in accordance with the EOTA Guidance document N° 004 on "The provision of data for assessment leading to ETA".

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 ETAs issued according to this ETAG, shall be in accordance with the principles laid down in the EC Guidance Paper on the use of EUROCODES in harmonised European technical specifications

The relevant Essential Requirements, the related requirements to product performances (as given in chapter 4), the corresponding product characteristics to be assessed and the corresponding verification methods are indicated in the following table:

Table 2: Relationship between ETAG paragraph on product performance, product characteristics and ETAG paragraph on verification method

ER	ETAG paragraph on product performance	Product characteristics	ETAG paragraph on verification method
1	§ 4.1.1 Resulting structural pattern	Geometry of the voids of the shuttering	§ 5.1.1 Resulting structural pattern Documents and trial structure
	§ 4.1.2 Efficiency of filling	Capability of the shuttering to produce a satisfactory concrete infill Tightness of the shuttering	§ 5.1.2 Efficiency of filling Trial structure
	§ 4.1.3 Possibility of steel reinforcement	Compatibility of the shuttering with correct reinforcement	§ 5.1.3 Possibility of steel reinforcement Drawings - Practice test
2	§ 4.2.1 Reaction to fire	Ignitability Rate of heat release Rate of spread of flame Rate of smoke production Flaming droplets/particles	§ 5.2.1 Testing of reaction to fire
	§ 4.2.2 Fire resistance	Load-bearing capacity Fire integrity Fire insulation Mechanical action Radiation	§ 5.2.2 Testing of fire resistance

ER	ETAG paragraph on product performance	Product characteristics	ETAG paragraph on verification method
3	§ 4.3.1 Release of dangerous substances	Content, Rate of release of dangerous substances	§ 5.3.1 Checking of declaration
	§ 4.3.2 Water vapour permeability § 4.3.3 Water absorption	Water vapour permeability Capillarity of the shuttering	§ 5.3.2 Testing or calculation of water vapour permeability § 5.3.3 Evaluation of water absorption
4	§ 4.4.1 Bond strength and resistance to impact load	Bond strength and resistance to impact load	§ 5.4.1 Testing , calculation or assessing
	§ 4.4.2 Resistance to filling pressure	Mechanical characteristics of the shuttering	§ 5.4.2 Testing and/or calculation
	§ 4.4.3 Safety against personal injuries	Safety against personal injuries by contact: – no sharp or cutting edges – nature of surface	§ 5.4.3 General examination
5	§ 4.5.1 Airborne sound insulation	Airborne sound insulation	§ 5.5.1 Testing of airborne sound insulation
	§ 4.5.2 Sound absorption	Sound absorption coefficient	§ 5.5.2 Testing of sound absorption coefficient
6	§ 4.6.1 Thermal resistance	Thermal resistance	§ 5.6.1 Calculation or testing of thermal transmission
	§ 4.6.2 Thermal inertia	Thermal inertia	§ 5.6.2 Information on relevant data
Aspects of durability and Serviceability	§ 4.7.1 Resistance to deterioration agents Resistance to normal use damages	Resistance to deterioration agents Resistance to normal use damages	§ 5.7.1 Evaluation of the resistance to deterioration by : – physical agents – chemical agents – biological agents § 5.7.2 Evaluation of the resistance to normal use damages by : – normal use impacts – incorporation of ducts – fixing of objects

5.1 MECHANICAL RESISTANCE AND STABILITY

5.1.1 Resulting structural pattern

The type and the dimensions of the voids determining the structural pattern of the concrete in-fill shall be identified from drawings of the blocks or panels and tolerance specifications provided by the ETA applicant. The dimensions and shapes of the blocks or leaves shall be determined.

Compatibility of different types of blocks (e.g. half-blocks, corners etc…) shall be checked to ensure they maintain the structural pattern.

From the filling test (see below) the resulting verticality of the wall shall be checked.

The installation shall be in accordance with ETA applicant instructions including method of placement and maximum pour height.

5.1.2 Efficiency of filling

The efficiency of filling shall be determined by erection of a trial structure, according to the ETA applicant instructions, preferably on site, for inspection.
The trial structure shall include as many typical details as possible, for example, if appropriate for the kit :

- window openings and/or door openings
- corners
- junctions with internal walls
- lintels as prescribed for the kit
- floor and roof junctions (e.g. timber, precast or in-situ concrete as prescribed for the kit)
- incorporation of horizontal and vertical reinforcement up to the maximum percentage prescribed for the kit
- site made cuts and joints of blocks or panels
- services passing through the wall

The trial structure shall be inspected for :

- tightness : joints and details shall be inspected to determine any loss of fines.
- completeness of fill :

an indication of completeness of fill may be obtained by observing the presence of laitence at joints.

The shuttering shall be removed to observe the soundness of the hardened concrete and any adverse reaction caused by the capillarity of the shuttering faces. Positions to be inspected include :

- lintel bearing areas
- corners, as the geometric pattern may be different
- around the openings
- bearing areas for floors and roofs
- at reinforcement
- at spacers

The concrete shall be inspected for full compaction, voids or segregation. Cores may also be taken and examined to check correct compaction, this may be necessary where the removal of the shuttering leaves a poor surface and at spacers. Compressive strength of the concrete in such places may be assessed according to prEN 206-1 and be compared to the strength of plain, correctly compacted areas of wall to determine any effects on properties.

- correct setting and hardening

The concrete shall be inspected for correct setting and hardening which, for example, may be influenced by the capillarity of the shuttering.

When selecting the shuttering samples for the above tests the effects of production tolerances shall be considered. Products from different batches and production lines shall be mixed to ensure compatibility.

Experience of the ETA applicant can be taken into consideration.

5.1.3 Possibility of steel reinforcement

The possibility of steel reinforcement for reinforced concrete walls and, at least the minimum required reinforcement for non reinforced concrete walls, shall be evaluated by examining drawings or when necessary by practice tests, preferably on site. The minimum reinforcements to examine are :

- the ring anchor nearby every floor or ceiling;
- the reinforcement of lintels, if the kit includes this possibility;
- the reinforcing of the parapets;
- the interconnection of walls;

The reinforcement cover shall also be determined.

Additional structural reinforcements, especially those required for building in seismic areas (intermediate vertical and horizontal links) shall be assessed according to the intended use claimed by the ETA applicant. When the shuttering kit provides cover spacers, it shall be assessed that the kit efficiently holds the reinforcement in place and provides suitable cover to this reinforcement. Experience of the ETA applicant can be taken into consideration.

5.2 SAFETY IN CASE OF FIRE

In all cases the fire characteristics can be determined by testing according to the standards listed below.

5.2.1 Reaction to fire

Reaction to fire tests for shuttering kits with or without finishes including ignitability, rate of heat release, rate of spread of flame, rate of smoke production and flaming droplets/particles are performed through the classification standard EN 13501-1 (test methods for the Euroclasses A1-E). If no performance is determined, the products fall in class F without testing.
Shuttering kits which comprise materials included in the Commission Decision 2000/605/EC can be considered as Euroclass A_1 without testing.
In all cases the layers susceptible to be involved in fire situation shall be tested for classification.

5.2.2 Resistance to fire

Testing is performed as described through the classification standard prEN 13501-2. In some cases of grid and column pattern covered with mechanically fixed finishes, an evaluation without testing could be undertaken by a notified fire laboratory. Such an evaluation will generally not be possible with bonded finishes.
In this case, the experimental verification of finishes stability under fire could be established using partial samples (at least 1 m²) with representative structural patterns.

5.2.2.1 Load bearing walls

Exposure/action:
(a) standard temperature/time curve
(b) impact, representing structural failure of other components in case of fire

Performance criteria

(a) load bearing capacity	R
(b) load bearing capacity and integrity	RE
(c) load bearing capacity, integrity and insulation	REI
(d) load bearing capacity, integrity, insulation and mechanical action	REI-M
(e) for parts with insufficient I, load bearing capacity, integrity and radiation	REW

Testing of load bearing walls is performed as described in :
EN 1363-1 : 1999 *Fire resistance tests- Part 1 : General requirements*
EN 1363-2 : 1999 *Fire resistance tests- Part 2: Alternative and additional procedures*
EN 1365-1 : 1999 *Fire Resistance Tests for loadbearing elements- Part1: Walls*

5.2.2.2 Non load-bearing walls

Exposure/action:
(a) standard temperature/time curve
(b) impact, representing structural failure of other components in case of fire

Performance criteria

(a) integrity	E
(b) integrity and insulation	EI
(c) integrity, insulation and mechanical reaction	EI-M
(d) integrity and radiation (for elements with insufficient I)	EW

Testing of non load bearing walls is performed as described in :
EN 1363-1 : 1999 *Fire resistance tests- Part 1 :General requirements*
EN 1363-2 : 1999 *Fire resistance tests- Part 2: Alternative and additional procedures*
EN 1364-1 : 1999 *Fire resistance tests for non-loadbearing elements- Part 1 : Walls*

5.2.2.3 Façades (curtain walls) and external walls

Exposure/action
(a) standard temperature/time curve (from the inside)
(b) external fire exposure curve

Performance criteria
(a) integrity E
(b) integrity and insulation EI
(c) mechanical stability

Where required mechanical stability means that there are no falling parts liable to cause personal injury during the time for the E or EI classification.

Testing of façades is performed as described through the classification standard prEN 13501-2

5.3 HYGIENE, HEALTH AND THE ENVIRONMENT

5.3.1 Dangerous substances

5.3.1.1 Presence of dangerous substances in the product
The applicant shall submit a written declaration stating whether or not the product/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.

5.3.1.2 Compliance with the applicable regulations
If the product/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).

5.3.1.3 Application of the precautionary principle
An EOTA member has the possibility to provide to the other members, through the Secretary General, warning 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 data base, and will be transferred to the Commission services.

The information contained in this EOTA data base 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 which raised the issue.

5.3.2 Water vapour permeability

The product specifications and performance shall be examined and in respect of exposure to moisture assessed on the basis of known material properties (EN 12524: 2000), 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 EN 12086:1997, *Thermal insulating products for building applications - Determination of water vapour transmission properties*.

Alternatively prEN ISO 12572 "*Hygrothermal performance of building materials and products – Determination of water vapour transmission properties*" (ISO/DIS 12572:1997) may be used.

5.3.3 Water absorption

The aspects of this verification are covered by 5.1.2. with respect to capillarity of the shuttering faces and by 5.3.4 with respect to moisture proofing. Suitability of the shuttering kit in this respect will be assessed on the basis of the methods referred to in the respective clauses.

5.3.4 Watertightness

The achievement of adequate watertightness by the wall shall be assessed (in the case of an incorporated finish) on the basis of the specification for the finish and its application (e.g. means of achieving watertightness of joints between finish components according to installation instructions).
When special internal environment protection is necessary (e.g. rooms with splashing water and/or high humidity), it shall be assessed that finishes providing adequate watertightness can be properly applied.

When the use for underground walls is stated as possible by the installation instructions, it shall be assessed that incorporated finishes and their joints are able to provide by themselves adequate watertightness or to provide adequate support for common moisture proofings, if watertightness is needed.

Where relevant, the assembled system shall be assessed in relation to the practical incorporation of conventional moisture resisting measures.

5.4 SAFETY IN USE

5.4.1 Bond strength and resistance to impact load

The stability of the shuttering facings under the loads due to intrinsic weight, wind pressure and suction and under the impact loads under normal use and normal traffic shall be evaluated.

The stability of the shuttering facing can be governed by :

- the bond strength between finish and its direct support,
- the bond strength between layers of a multilayers shuttering leaf and the tensile strength perpendicular to faces of the layers materials.

The pressure applied to a shuttering by the fresh concrete infill being poured from the maximum height prescribed by the installation guide of the ETA applicant is assumed to be higher than the possible depressure applied by wind suction. Thus there is generally no need for bond strength between shuttering leaf and concrete. Nevertheless, in specific cases particularly with corrugated insulating leaves, the ETA applicant may claim for a bonding value between a shuttering leaf and the hardened concrete. The corresponding testing procedure is adressed hereafter.

The assessment and/or testing relating to bond strength shall possibly include a consideration of the type of finish. Four types of internal and external finishes can be identified, the first three are normally not part of the kit :

- on site applied e.g. render, plaster
- self-supporting mechanically fixed e.g. brickwork
- mechanically fixed e.g. cladding
- incorporated to the shuttering kit

5.4.1.1 Bond strength between finish and its direct support

This section applies to shuttering kits with incorporated finishes.
(a) Incorporated render type finishes on insulation leaf :
The relevant testing methods of ETAG 004 ETICS (External Thermal Insulation Composite Systems with rendering) shall be used, possibly adapted to specific needs, to determine the bond between the finish and the insulation material.
(b) Mortar type finishes on masonry substrates.
For mortar type finishes on clay, concrete, lightweight aggregate concrete and autoclaved aerated concrete substrates the relevant testing method is EN 1015-12:2000 "Methods of test of mortar for masonry – Part 1.2: Determination of adhesive strength of hardened rendering and plastering mortar on substrates".

(c) Other types of incorporated finishes
Depending on the nature of the finish and of its fixing technique (bonding or mechanical fixing), its adhesion to the support shall be determined by the relevant testing methods described in ETAG 004 ETICS or, if necessary, by any other relevant testing method.

5.4.1.2 Bond strength between layers of a shuttering leaf

This section applies to shuttering kits with multiple layers bonded or mechanically linked, the external ones being intended to be supports for finishes.
The bond strength between layers and the tensile strength perpendicular to faces of the leaf components shall be assessed :

- by pure testing, with appropriate device (see testing references below), on single elements (hollow blocks) or on samples cut out of a panel in the case of pure bonding,
- by calculation in the case of binding by pure mechanical interlock of well known materials, justifying by certification their own tensile strength. At least the failure mode should be verified by testing.

References for tensile test : EN 1607 : 1996/AC : 1997 *Thermal insulating products for building applications - Determination of tensile strength perpendicular to faces* and prEN 13168 *Thermal insulation products for buildings. Factory made products of Wood Wool and Wood wool composite slabs - Specification.*

5.4.1.3 Bond strength between shuttering leaf and concrete

This section applies only to shuttering kits for which the supporting documents held to the Approval Body claim for a bonding value between a shuttering leaf and the hardened concrete.
In this case, the bonding value shall be assessed :

- in the case of plain bonding by testing with appropriate device (see 5.4.1.2) on leaf samples cut of the trial structure (see 5.1.2)
- in the case of bonding by pure mechanical interlock, by calculation based on the geometry of the interlocked parts and the tensile strength of the leaf material and of the concrete core (this one taken from ENV 1992-1-1-1991). At least the failure mode should be verified by testing.

5.4.1.4 Resistance to impact load

The safety resistance to impact load of the wall is mainly governed by the design of the concrete infill (concrete sections, concrete resistance, reinforcement, distance between grid or columns members where relevant, ...). It is assumed that, when correctly designed the concrete infill provides for the safety resistance of the completed wall under impact loads. The only risk is that of shuttering fragments detaching and falling under hard and soft body impact load. Resistance to this type of load is only evaluated for incorporated finishes.

Testing of shuttering systems in end use conditions with respect to impacts from a small hard body and a small soft body is performed as described in MOAT 43:1987 UEAtc, *Directives for Impact Testing Opaque Vertical Building Components*.
Assessment without testing is possible when the incorporated finish and/or its support in the kit are made of materials which are not brittle and have a known satisfactory performance (e.g. metal finish on concrete shuttering leaf).

5.4.2 Resistance to filling pressure.

Failure of the shuttering may occur due to :

- inadequate tensile strength of spacers
- inadequate bending strength of shuttering leaf
- failure of connection spacer to shuttering leaf
  - pull through/pull out strength of spacer to leaf connection
  - shear strength of spacer anchorage (when anchorage is in a cantilever position)

As there is a large variety of shuttering kits on the market, it is not possible to give in general detailed test methods. The relevant failure mode of the shuttering shall be determined by applying appropriate methods.
Three types of methods can be used :

- testing of the complete shuttering
- calculation based on materials strength
- calculation (for instance metallic spacers strength) and partial testing (for instance anchoring of metallic spacers into shuttering leaves).

5.4.3 Safety against personal injuries

Shuttering kits with incorporated finishes shall be assessed as follows :

- Existence of sharp or cutting edges :
  No tests are necessary for the assessment of the presence of sharp or cutting edges. The product, the product specification and trial installations shall be examined to confirm that sharp or cutting edges are not present at, for example, corners, protrusions, joints or trims.
- Nature of surfaces :
  No tests are necessary for the assessment of the nature of the surface. The product specifications and the products shall be examined to determine the surface texture and any risk of abrasion or cutting to people.

5.5 PROTECTION AGAINST NOISE

5.5.1 Airborne sound insulation

The testing of walls for airborne sound insulation is performed under end use conditions in accordance with EN ISO 140-3:1995*, Acoustics – Measurement of sound insulation in buildings and of building elements – Part 3 : Laboratory measurements of airborne sound insulation of building elements.*

Alternatively, calculations may be conducted in accordance with EN 12354: 2000 *Building acoustics - Estimation of acoustic performance of buildings from the performance of elements (*Part 1 : *Airborne sound insulation between rooms* - Part 3 : *Airborne sound insulation against outdoor sound)*

5.5.2 Sound absorption

Testing of the sound absorption coefficient of materials is performed under end use conditions as described in :

EN ISO 354 : 1993, *Acoustics – Measurement of sound absorption in a reverberation room* and

EN ISO 354/A1:1997, *Acoustics – Measurement of sound absorption in a reverberation room – Amendment 1: Test specimen mountings for sound absorption tests*

5.6 ENERGY ECONOMY AND HEAT RETENTION

5.6.1 Thermal resistance

Thermal transmission coefficients shall be determined by calculation or testing.

Testing is necessary in the cases where thermal conductivity of the insulating material is assumed to be affected by the action of fresh concrete (e.g. compression of insulating leaf or penetration of concrete into insulation voids.

Calculation of the thermal insulation characteristics is conducted in accordance with the following:

EN 12524:2000, *Building materials and products - Hygrothermal properties - Tabulated design values*

EN ISO 6946:1996, *Building components and building elements – Thermal resistance and thermal transmittance – Calculation method (ISO 6946:1996)*

Testing and determination of thermal characteristics are conducted in accordance with the following:

EN ISO 8990:1996, *Thermal Insulation – Determination of steady-state thermal transmission properties – Calibrated and guarded hot box (ISO 8990:1994)*.

ISO 8301:1991, *Thermal insulation – Determination of steady-state thermal resistance and related properties – Heat flow meter apparatus*

ISO 8302:1991, *Thermal insulation – Determination of steady-state thermal resistance and related properties – Guarded hot plate apparatus*

EN ISO 10456: 1999, *Building materials and products – Procedure for determining declared and design thermal values*

5.6.2 Influence of moisture transfer on insulating capacity of the wall

The possible influence of moisture transfer on the insulating capability of the wall due to surface condensation and interstitial condensation shall be evaluated by calculation according to prEN ISO 13788, *Hygrothermal performance of building components and building elements-Estimation on internal surface temperature to avoid critical surface humidity and calculation of interstitial condensation.*

5.6.3 Thermal inertia

The following information is required to calculate the thermal inertia of the wall:

- total mass per unit area (in kg/m²) of the part of the wall which is internal face versus insulation sheet(s)
- density of materials used (in kg/m^3)
- heat capacity of materials used (in J/kg K)
- thermal transmittance of materials used (in W/m² K).

5.7 ASPECTS OF DURABILITY AND SERVICEABILITY

5.7.1 Resistance to deterioration

Evaluation of the resistance to deterioration applies mainly to the shutterings kits with incorporated finishes.

5.7.1.1 Physical agents

A suitably designed structural concrete infill will ensure adequate resistance to physical agents. On this assumption, it can be considered that the risk of deterioration or deformation of the shuttering under end use conditions by the defined physical agents depends only on the sensitivity of the kit component materials (e.g. brittleness under very low temperatures)

The evaluation of the behaviour of the shuttering components shall be conducted using performance diagrams for the component materials according to the corresponding parameters (mainly temperature) taking into account the extreme values claimed for by the ETA applicant.

For kit components made with materials of known composition and proven successful long term use in the exposure conditions claimed for by the ETA applicant, an assessment can be made without testing.

For shuttering materials likely to be adversely affected by temperature increase generated locally by heating panels, a trial wall sample shall be subjected on one of the faces to a localised radiation allowing the temperature of the exposed parts to reach approximately 50°C for 6 hours.

After the test, the deformation of the shuttering shall be measured.

5.7.1.2 Chemical agents

- Corrosion

The product specification for both shuttering leaves and spacers shall be examined to determine whether the protection against corrosion is appropriate for the intended use.

- Cleaning agents

The product specification dealing with the nature of the surfaces shall be examined.

Where materials of known composition and performance are used, an assessment can be made without testing.

Where materials of unknown composition and performance are used, or where the manufacturer makes specific claims, or where the location of the shuttering finishes is such that cleaning is an important requirement, test shall be conducted in accordance with EN 423: 1993, *Resilient floor coverings – determination of the effect of stains* to check the reaction of the finish to substances it is likely to encounter in service.

5.7.1.3 Biological agents

The product specification shall be examined and the materials used assessed to determine whether the protection against fungi, bacteria, algae and insects is appropriate for the intended use and whether they will provide food value or contain voids suitable for habitation by vermin. This is particularly important if they are intended for use in food preparation areas.

5.7.2 Resistance to normal use damages

Resistance to normal use damages shall be assessed in the case of incorporated finishes by engineering judgement or by testing.

5.7.2.1 Normal use impacts

Assessment without testing is possible when the incorporated finish and/or its support in the kit are made of materials which are not brittle and have a known satisfactory performance in this respect (e.g. concrete wall of a block).
Testing of the shuttering system in end use conditions is performed according to the same reference document as in 5.4.1.4, completed with the energy values given in 6.4.1.4.

5.7.2.2 Incorporation of ducts

When the installation guide states that parts of the kit components are factory managed or can be on site managed to give passing to ducts, it shall be assessed that the geometry of voids does not damage the integrity of any of the kit components to a degree likely to reduce noticeably its function as insulating part of the wall or as finish or finish support.

5.7.2.3 Fixing of objects

On the basis of the installation guide data (see 7.2.7) it shall be assessed that loads range and the common types of fixings stated in the installation guide as possibly bearing on the shuttering kit do not damage the integrity of any of the kit components to a degree likely to reduce noticeably its function as insulating part of the wall or as finish or finish support.

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

This chapter details the performance requirements to be met by a Shuttering System (chapter 4) 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, using the outcome of the verification methods (chapter 5).

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

Table 3: Relationship between product performances to be assessed and expressions of classification, categorization and declaration

ER	ETAG paragraph on product performance to be assessed	Class/Use category/Numeric value
1	§ 6.1.1 Resulting structural pattern	type of the structural pattern
	§ 6.1.2 Efficiency of filling	Satisfactory
	§ 6.1.3 Possibility of steel reinforcement	Satisfactory
2	§ 6.2.1 Reaction to fire	Euroclasses A_1 to F
	§ 6.2.2 Fire resistance	R15 – 240 RE 20 – 120 REI 15 –240 REIM 30-120 REW 20-240 E 20 – 120 EIM 30 – 120 EI 15 – 240 EW 20 - 120 No performance determined
3	§ 6.3.1 Release of dangerous substances	Formaldehyde class (Wood-based panels) Indication of content of asbestos Indication of content of other dangerous materials “No dangerous materials”
	§ 6.3.2 Water vapour permeability	Water vapour resistance of materials No performance determined
	§ 6.3.3 Water absorption	Satisfactory
	§ 6.3.4 Watertightness	Satisfactory No performance determined
4	§ 6.4.1 Bond strength and resistance to impact load	Satisfactory No performance determined
	§ 6.4.2 Résistance to filling pressure	Satisfactory
	§ 6.4.3 Safety against personal injury by contact	Description No performance determined
5	§ 6.5.1 Airborne sound insulation	Single number rating No performance determined
	§ 6.5.2 Sound absorption	Single number rating No performance determined
6	§ 6.6.1 Thermal resistance	R-value No performance determined
	§ 6.6.2 Thermal inertia	Information on relevant data No performance determined
Aspects of durability and serviceability	§ 6.7.1 Protection against deterioration caused by: – physical agents – chemical agents – biological agents	 Satisfactory Satisfactory Satisfactory
	§ 6.7.2 resistance to normal use damages – normal use impacts – incorporation of ducts – fixing of objects	 Satisfactory Satisfactory Satisfactory

6.1 MECHANICAL RESISTANCE AND STABILITY

6.1.1 Resulting structural pattern

The results of the assessment of the specification shall be used to define the type of structural pattern e.g. continuous, grid, column etc, and identify the characteristics and any limitations of the void to be reported in the ETA in order to allow the designer of the building to design the concrete in accordance with prEN 206-1 and ENV 1992-1-1:1991 Eurocode 2 or with test results.

6.1.2 Efficiency of filling

The manufacturer specifications shall be assessed in relation to concrete characteristics (minimum strength, consistency and maximum aggregates size, …) and methods of concreting (height of pouring, maximum height of filling, method of filling…) are satisfactory in relation to the specific geometry of the voids to be filled (minimum thickness of continuous type wall or minimum cross sections of grid and column types).
The trial structure shall be assessed to verify that the shuttering has been filled up efficiently without bursting, voids, any uncovered reinforcement or distortion in concrete members.

6.1.3 Possibility of steel reinforcement

The possible arrangements of reinforcement shall be assessed. The assessment should cover at least the minimum required reinforcement.
The minimum reinforcements to be assessed are:

- the ring anchor at every floor or ceiling;
- the reinforcement of lintels, if relevant;
- the reinforcement of the parapets;
- the interconnection of walls.

The practicability of placing the reinforcement with sufficient cover and maintaining it in right place during concrete casting shall be assessed.

If the placing of the required minimum reinforcement is difficult, supporting information shall be provided.

6.2 SAFETY IN CASE OF FIRE

The classification of walls resulting from testing is given in the ETA.

6.2.1 Reaction to fire

Classification of walls with respect to reaction to fire is given in accordance with
EN 13501-1 *Fire classification of construction products and building elements*
Part 1 : Classification using data from reaction to fire tests
The following range of Euroclasses is used : A_1 to F

6.2.2 Resistance to fire

Classification of walls with respect to resistance to fire is given in accordance with

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

The performance criteria shall be taken from the following list.

In case of lack of fire resistance test data, a classification of walls based on the geometry of the infilled concrete structure can be derived from ENV 1992-1-2:1995. As the transposition of the tables given in this reference document needs some interpretation, a common approach is proposed in Annex C for the attention of the Approval bodies.

6.2.2.1 Classification of load bearing walls

a) with separating function :

RE		20	30		60	90	120		
REI	15	20	30	45	60	90	120	180	240
REI-M			30		60	90	120		
REW		20	30		60	90	120	180	240

Where

RE Classification with respect to load bearing capacity and integrity.
REI Classification with respect to load bearing capacity, integrity and insulation.
REI-M Classification with respect to load bearing capacity, integrity and insulation when particular mechanical actions (e.g. dynamic loads) are considered.
REW Classification with respect to load-bearing capacity, integrity and maximum radiation level

b) without separating function :

R	15	20	30	45	60	90	120	180	240	360

Where

R Classification with respect to load bearing capacity

6.2.2.2 Classification of non load bearing walls :

E		20	30		60	90	120		
EI	15	20	30	45	60	90	120	180	240
EI-M			30		60	90	120		
EW		20	30		60	90	120		

Where
E Classification with respect to integrity
EI Classification with respect to integrity and insulation
EI-M Classification with respect to integrity, insulation and mechanical action
EW Classification with respect to integrity and maximum radiation level

6.2.2.3 Classification of façades and external walls :

E	15		30	60	90	120
EI	15		30	60	90	120
EW		20	30	60		

Where
E Classification with respect to integrity
EI Classification with respect to integrity and insulation
EW Classification with respect to integrity and maximum radiation level

Test and classification may also be performed from one side only. Whichever test(s) is/are performed and classification(s) determined, the classes are identified by :
"i $\rightarrow$ o" when tested from inside to outside, and
"o $\rightarrow$ i" when tested from outside to inside.
"o $\leftrightarrow$ i" when tested from inside to outside and from outside to inside

6.3 HYGIENE, HEALTH AND THE ENVIRONMENT

6.3.1 Dangerous substances

The product/kit 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 on 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

6.3.2 Water vapour permeability

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. Where properties such as water vapour permeability are not known, they shall be determined by testing.
It shall be established that condensation in the wall as a result of water vapour diffusion will not occur or will occur only to an extent where damage is not caused during the condensation period and that the wall will dry out again during the evaporation period.

6.3.3 Water absorption

The products specifications shall be examined and performance in respect of exposure to moisture assessed on the basis of know material properties, design details and the intended use.
It shall be established that water absorption by the shuttering in contact with fresh concrete or from internal or external sources will not occur or will occur only in a position and to an extent where damage is not caused and that the shuttering will dry out again during the evaporation period.

6.3.4 Watertightness

This criterion is particularly relevant for the incorporated finishes. The product specifications shall be examined and performance in respect of watertightness of the wall in end use conditions assessed on the basis of known materials properties, design details (particularly constitution of the composite wall with respect to the category of the structural pattern, means of achieving watertightness of joints between finishes components, ability to provide adequate support for common moisture proofings) and the intended uses, such as stated in the installation instructions, with the corresponding exposures to rain or snow, or water from the ground in case of underground or basement walls.

6.4 SAFETY IN USE

6.4.1 Bond strength and resistance to impact load

6.4.1.1 Bond strength between finish and its direct support :

(a) For incorporated render type finishes on insulation leaf, the bond strength shall be in accordance with the ETAG 004 ETICS. In particular the tensile strength of the part of the kit which is intended to act as a support for reinforced base coat of an ETICS shall have a tensile strength according to the requirements of the ETAG 004 ETICS.

(b) Other types of incorporated finishes.
The bond strength shall be proved to satisfy the requirement stated in 6.4.1.2.

6.4.1.2 Bond strength between layers of a shuttering leaf

The specification for the minimum tensile strength perpendicular to the faces of the shuttering to be withstood by the connections between the kit components is : 0,02 N/mm².
This value shall be justified by test results or by a calculation according to 5.4.1.2.

6.4.1.3 Bond strength between shuttering leaf and concrete

Where required the value shall be stated in the ETA.

6.4.1.4 Safety resistance to impact load

In the case when the resistance to impact load is assessed by testing, according to 5.4.1.4, the energy to be applied is 60 Nm with small soft body and 10 Nm with hard body and the criteria of acceptance are, for both : no fall nor appearance of harmful fragment.

6.4.2 Resistance to filling pressure

The shuttering shall provide adequate resistance under the most extreme filling conditions specified by the manufacturer (for instance maximum rate of filling, maximum pouring height, etc…). The following criteria shall therefore be met:

- no crack nor failure in current position and at junctions,
- no significant irreversible bowing (absolute deflexion value not exceeding 5 mm).

6.4.3 Safety against personal injuries

The nature of surface shall be described in qualitative terms with regard to the potential risk of injuries (e.g. abrasion, sharp or cutting edges).

6.5 PROTECTION AGAINST NOISE

6.5.1 Airborne Sound Insulation

The measured airborne sound insulation is expressed as a single number rating, R_w, in accordance with EN ISO 717-1:1996, *Acoustics – Rating of sound insulation of buildings and in building elements – Part 1: Airborne sound insulation (ISO 717-1:1996).*

6.5.2 Sound Absorption

Sound absorption is considered only for walls with a factory made finish.

The measured acoustic absorption is expressed as a single number rating in accordance with :
EN ISO 11654: 1997, *Acoustics – Sound absorbers for use in buildings – Rating of sound absorption.*

6.6 ENERGY ECONOMY AND HEAT RETENTION

6.6.1 Thermal resistance

The calculated or measured value of the thermal resistance of the shuttering (R-value) in m^2 K/W shall be stated in the ETA. 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.

6.6.2 Influence of moisture transfer on insulating capacity of the wall

Analysis of the wall structure with it's permitted finishes is conducted in accordance with the methods given in section 5 and shall indicate that at the winter climatic extremes any moisture accumulation in the inner wall will not adversely affect the insulating capability of the wall to a significant extent.

If any region of the wall is below the winter mean dew point then it must be assessed for it's durability and acceptability, on the basis of the moisture accumulation rate derived from the methods given in section 5.
Particular attention may have to be given to joints and the location of bridging elements.

6.3.3 Thermal Inertia

The information required to calculate the thermal inertia of the completed wall: position of the insulating sheet(s) determined masses to be taken into account, value of such masses per unit area, heat capacity of special materials, shall be stated in the ETA.

6.7. ASPECTS OF DURABILITY AND SERVICEABILITY

6.7.1 Resistance to deterioration

The risk of premature ageing of kit elements related to the working life and serviceability of the shuttering kit (see section two, general note d) shall be assessed mainly by engineering judgement based on proven material characteristics at the extreme environmental conditions claimed for by the ETA applicant in the supporting document for the ETA.

Proof shall be given in the supporting document and may relate to significant experience of use of the

materials or elements in the relevant environmental conditions.

Where relevant this shall relate to compatibility of materials

6.7.1.1 Physical agents

The proof of satisfactory behaviour for parts of the kits exposed to the action of physical agents of deterioration will generally consist of performance test results on the materials or elements in extreme conditions (temperature, freeze-thaw cycles,…).
When tested in accordance with clause 5.7.1.1 relating to the effect of radiation, the incorporated finish shall be checked to ensure that its properties have not been impaired by loss of adhesion, fracture or deformation. The absolute deflexion value shall not exceed 5 mm.

6.7.1.2 Chemical agents

- Corrosion of metallic finishes and spacers.
The assessment shall confirm that the specifications related to protection against corrosion of these elements are appropriate for the intended use of the shuttering kit. This requirement concerns the external parts of the spacers likely to be damaged by environmental conditions (e.g. parts of metallic spacers not covered by concrete infill and not surely protected from rain penetration through the external finish). In this case, reference shall be made to the exposure classes related to environmental actions in prEN 206-1:2000 clause 4.1.

- Cleaning agents
The assessment of surfaces of known composition and performances shall be reported in qualitative terms.

6.7.1.3 Biological agents

The result of the assessment is examined and preventive measures or limitations in use determined. The susceptibility to infestation by insects and vermin is described.
- The conditions for attack by biological agents of shuttering kit containing wood or wood-based components may be regarded as in hazard class 1 as defined in EN 335-1:1992 - *Durability of wood and derived materials - Definition of hazard classes of biological attacks - Part 1 : General*, when they are intended to be used in internal walls. Therefore treatment of such components is not necessary. When they are intended to be used for internal part of external walls or externally in this type of wall, the exposure conditions are hazard class 2 and, therefore, should be treated accordingly.

6.7.2 Resistance to normal use damages

The risk of insufficient resistance of kit components to normal use damages shall be assessed mainly by engineering judgement based on proven material characteristics. In the case of brittle finishes or finishes supports, testing may be necessary.

6.7.2.1 Normal use impacts

The resistance to impacts loads for retention of performances shall be assessed by testing in the same cases as for safety resistance to impact loads (see 5.4.1.4). Besides the bodies and energy values given in 6.4.1.4 the energy to be applied here is 400 Nm with large soft body and the criteria of acceptance are those indicated in M.O.A.T. n°43:1987.

6.7.2.2 Incorporation of ducts

The assessment of “satisfactory” corresponding to “no unacceptable damage” for “on site” managed passing for ducts in the kit components, shall be done on the basis of the installation guide given by the ETA applicant. The maximum dimensions of the “on site” managed ducts shall be given in the ETA.

6.7.2.3 Fixing of objects

The assessment of “satisfactory” for the ability of the kit to withstand without damage and without need for anchoring in the concrete structure the stated loads range with the corresponding common types of fixings (nails, screws, anchors,…) shall be done on the basis of nature and characteristic resistance of the finishes components and of the bond strength assessed in 6.4.1.

6.8. IDENTIFICATION OF THE PRODUCT

All components of the shuttering kit shall be clearly identified. Where possible, reference to harmonised European Standards shall be made.

Where components are not covered by harmonised European Standards, their materials shall be described in a chemically unambiguous formula and identified by standard tests (e.g. fingerprinting tests). All components/amounts shall be specified either by weight, volume or percentage, with appropriate tolerances. They shall be precisely defined by reference to physical characteristics, such as geometry, density, mechanical resistance, etc…

The determination of the product characteristics shall be based on testing in accordance with the appropriate CEN or EOTA test methods as far as they exist.

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

7.1 GENERAL

This chapter sets out the assumptions and recommendations for design packaging, transport, storage installation and execution, 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).

7.2 DESIGN OF THE WORKS

7.2.1 General

The conditions for design and installation of the shuttering kit into the works shall be taken from the manufacturer's installation instructions. The adequacy of these instructions shall be assessed.
The main points to assess are the following :

- Reduction of the risk of surface and interstitial condensation in the works :
  - this type of risk is mainly dependent on the classical use of heating and ventilation devices (generally not part of the kit) and any necessary vapour control layer (possibly part of the kit).

- Watertightness :
  - design details stating the means for achieving watertightness of joints between finishe components, when relevant, in relation with intended exposures to rain or snow or water from the ground in case of use for underground or basement walls.

- Thermal resistance :
  - thermal bridges

- Sound insulation :
  - air paths through gaps, cracks, holes
  - flanking transmission
  - type of fixings

- Infestation :
  - sealing of voids
  - closure of small apertures

The installation instructions are supporting documents for the ETA and shall therefore always accompany the delivered kit.

The shuttering kit does not determine by itself all the characteristics of the wall in end use conditions. In particular the finishes may not always be incorporated in the kit since the ETA-applicant has two possibilities :

1) The supporting documents for the ETA quote the exact finishes to be combined with the kit. In this case, these finishes are part of the kit.

2) The supporting documents for the ETA quote only the types of finishes that can be combined with the kit (see 5.4.1). In this case, the finishes are not part of the kit but the ETA applicant shall prove that his kit is a satisfactory support for such types of finishes and that the assembled system has a sufficient impact resistance.
With any of these possibilities the supporting documents shall define any necessary surface preparation required to ensure that the shuttering acts as a suitable support (e.g. treatment of the surface prior to rendering or plastering and the fixing method for anchoring devices of self-supporting brickwork or claddings).

When the finish is the external component of an ETICS (External Thermal Insulation Composite System with rendering), the application of this finish shall be in accordance with the corresponding ETAs and ETAG and with the agreement of the corresponding ETA-holder.

7.2.2 Mechanical aspects

The basic assumption is that the shuttering kit is compatible with the design of the concrete structural pattern (continuous, grid and column type) according to ENV 1992-1-1:1991 and ENV 1992-1-6:1994 or national rules valid in the place of use. Otherwise, the structural pattern should be assessed by testing and in this case the results should be reported by the ETA applicant.

In both cases, the designer takes the responsibility to check the applicability of the assumption he makes.

For grid pattern, the minimum dimension of the filling sections related to relevant concrete properties are assumed to be in accordance with the following table :

Minimum dimension of the filling section	Concrete properties
<12 cm	Concrete according to EN 206 maximum aggregate size 8 mm, class of slump ≥ F5
12 cm ≤ < 14 cm	Concrete according to EN 206 maximum aggregate size 16 mm, class of slump ≥ F3
≥ 14 cm	Concrete according to EN 206 maximum aggregate size 32 mm, class of slump ≥ F2

For all patterns the maximum aggregate size is assumed be at least 8 mm.
For the concrete walls of grid type ENV 1992 (parts 1-1 and 1-6) do not provide a design method for in plane shear forces. For this reason, Annex B gives a proposal that can be used in absence of applicable national or harmonised methods.

7.2.3 Hygrothermal aspects

It shall be established by calculation that condensation inside the completed wall system as a result of water vapour diffusion will not occur at all or will occur only to an extent that no damage is caused during the condensation period and that the wall will dry out again during the evaporation period.

Calculation of the hygrothermal performance of the wall is conducted as described in

prEN-ISO 13788, *Hygrothermal performance of building components and building elements - Estimation of internal surface temperature to avoid critical surface humidity and calculation of interstitial condensation (ISO/DIS 13788:1997),* or by more general methods.

EN ISO 10211-1:1995, *Thermal bridges in building constructions –Heat flows and surface temperatures – Part 1: General calculation methods (ISO 10211-1:1995)*

EN ISO 10211-2:1995, *Thermal bridges in building constructions – Calculation of Heat flows and surface temperatures – Part 2 : linear thermal bridges*.

7.2.4 Sound Insulation

The acoustic properties of any wall or façade, whether internal or external are principally dictated by the sound transmission of the lowest sound insulation element present, virtually irrespective of it's proportion of the total superficial area. In general façades and walls may be penetrated by elements such as windows and doors therefore the sound insulation performance of any wall element might be expected to assume minor importance in meeting the Essential Requirement, unless special design precautions are taken.

7.2.5 Energy economy and heat retention

The thermal properties of many insulants and concrete is adversely affected by the presence of small quantities of moisture, therefore it shall be assumed that the basic wall structure shall be finished and protected from moisture from the ground, from weather or internally generated. It shall also be assumed that any moisture that does penetrate the wall is only temporary and that means exist for it's ultimate dispersion.

7.2.6 Provisions for services

Services to be incorporated in the wall are not addressed, and provisions made for the incorporation

of services are considered only to ensure that they will not adversely affect the properties and the performance of the wall. So, the installation guide shall state if the shuttering kit is compatible or not with the incorporation of services and, in case of possible incorporation, the parts of the kit components that can give passing to ducts.

7.2.7 Fixing of objects

The installation guide shall state which loads range with common corresponding types of fixings (nails, screws, anchors,…) the shuttering kit is able to withstand without damage and without need for anchoring in the concrete structure.

7.3 PACKAGING, TRANSPORT AND STORAGE

Materials shall be handled and stored with care, protected from accidental damage.

It is the responsibility of the materials provider to give the specific provisions to be applied to those who are concerned.

7.4 EXECUTION OF THE WORKS

The works shall be conducted by trained installers.

The ETA and the supporting documents shall include a detailed description of the installation of the system, specifying the required procedures (e.g. preparation of the foundation, assembling of the kit elements, installation of the possible reinforcement, concreting, installation of the finishes when they are not incorporated in the shuttering elements) the sequence and timing of operations (e.g. time allowed between concreting turns), the methods of concreting (e.g. pumping process in accordance with concrete aggregate size) amounts of materials used, as well as the temperature limits for installation.

In particular the specification for maximum aggregate size of fresh concrete and the consistency of the concrete (which are strongly linked to the geometry of voids of the shuttering kit) and the maximum pouring height (which governs the maximum concrete pressure on the shuttering leaves) are the responsibility of the ETA applicant and shall be given in the supporting documents and in the ETA.

To avoid unacceptable deformations caused by moisture movement of the products and prolonged drying, the moisture content of the blocks or panels of the shuttering should not significantly exceed equilibrium prior to the application of any finish.

7.5 MAINTENANCE AND REPAIR

The assessment of the fitness for use of the shuttering kit is based on the assumption that the finishes are normally maintained. In particular abrasions and minor impact damage are inevitable and shall be capable of easy repair without causing adverse effects.

Maintenance includes :

- repairs to localised damaged areas due to accidents,
- the application of various products or paints, possibly after washing or ad hoc preparation.

Necessary repairs should be effected rapidly.

It is important to be able to carry out maintenance as far as possible using readily available products and equipment, without spoiling appearance. Care should be taken not to use products which are incompatible with the shuttering kit.

SECTION THREE : ATTESTATION AND EVALUATION OF CONFORMITY (AC)

8. ATTESTATION AND EVALUATION OF CONFORMITY

Depending on the specific circumstances, the manufacturer can be the ETA holder and/or a component manufacturer and/or the kit manufacturer.

8.1 EC DECISION

The systems of attestation of conformity specified by the European Commission Decision 98/279/EC of 5/12/1997(EC OJ (L 127 of 24/4/1998), as amended and specified in the mandate CONSTRUCT 97/209 Rev 1- are as follows :

System 1 for shuttering systems for which the following is valid :

- intended use for the construction of external and internal walls subject to fire regulations, in buildings.
- reaction to fire classes A_1, A_2, B or C, 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)

System 2+ for the shuttering systems for which the following is valid :

- intended use for the construction of external and internal walls subject to fire regulations, in buildings,
- reaction to fire classes A_1, A_2, B, C for products/materials the production process of which does not fulfil the above criterion.
- reaction to fire class A_1 to E for products/materials that do not require to be tested for reaction to fire (e.g. products/materials of classes A_1 according to Commission Decision 2000/605/EC).
- reaction to fire classes D, E, F

and for the construction of external and internal walls not subject to fire regulations, in buildings.

The systems as described in Council Directive (89 /106/EEC) Annex III 2(i), 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 (see 8.2.2.1)

- initial inspection of the factory and of factory production control
- continuous surveillance, assessment and approval of factory production control.
- (audit testing of samples is not required)

System 2+:

(a) Tasks for the manufacturer

- factory production control
- initial type testing of the product (see 8.2.2.1)
- testing of samples taken at the factory in accordance with a prescribed test plan.

(b) Tasks for the approved body

- initial inspection of the factory and of factory production control
- continuous surveillance, assessment and approval of factory production control.

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 which complies with EN ISO 9000-series 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

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 non load-bearing permanent shuttering systems. Indirect methods will normally be sufficient, e.g. control of raw materials, manufacturing processes and properties of components.

8.2.1.3 Declaration of Conformity

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 section 5 of this ETAG. The approval body will have assessed the results of these tests in accordance with section 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 task for the approved body will be limited to the following characteristics:
Euroclasses characteristics for reaction to fire as indicated in the decision of the Commission 2000/147/EC *(where relevant)*
The work, done by the approval body for issuing the ETA, should be validated by the approved body for Certificate of Conformity purposes.

System 2+:

The work, done by the approval body for issuing the ETA, should be taken over by the manufacturer for Declaration of Conformity purposes.

8.2.3 Tasks for the approved body

8.2.3.1 Assessment of the factory production control system - initial inspection

System 1 and 2+:

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.

8.2.3.2 Assessment of the factory production control system – continuous surveillance of factory production control

System 1 and 2+:

Continuous surveillance, assessment and approval of the factory production control system are the responsibility of the approved body.

According to the mandate, parameters related to the following characteristics shall be of the interest of the approved body :
Euroclasses characteristics for reaction to fire as indicated in the decision of the Commission 2000/147/EC (where relevant),
Resistance to fire (in end use conditions) (for shuttering systems/kits based on blocks),
Resistance to filling pressure.

It is recommended that surveillance inspections be conducted at least twice per year. At least, surveillance inspection shall be conducted once a year.

8.2.3.3 Certification of Conformity and certification of Factory Production Control

The approved body shall issue :
Certification of Conformity of product (for system 1)
Certification of Factory Production Control (for system 2+)

8.3 DOCUMENTATION

In order to help the approved body to 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 for System 1 and 2+ generally form the basis on which the factory production control (FPC) is assessed by the approved body.

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 non load-bearing permanent shuttering systems 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 on an FPC test plan.
An agreed FPC test plan is necessary as current standards relating to quality management systems (EN ISO 9000-series, 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. 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. These will normally include :

- composition
- dimensions
- physical properties
- mechanical properties

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

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
- 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
- number of the ETA (valid as indications to identify the characteristics of the non load-bearing permanent shuttering systems and the characteristics where the ”no performance determined” approach is used).

SECTION FOUR: ETA CONTENT

9 THE ETA CONTENT

9.1 THE ETA CONTENT

9.1.1 Model ETA

The format of the ETA shall be based on the Commission Decision 97/571/EC, dated 22/07/1997 (EC Official Journal L236 of 27/08/1997).

9.1.2 Checklist for the issuing body

The technical part of the ETA shall contain information on the following items, in the order and with reference to the relevant 6 Essential Requirements. For each of the listed items, the ETA shall either give the mentioned indication/classification/statement/description or state that the verification/assessment of this item has not been carried out. The items are here given with reference to the relevant clause of this guideline:

- Indication of the assumed working life (Section Two, General Notes)
- Indication of the type of structural pattern, efficiency of filling and possibility of steel reinforcement (Clauses 6.11 – 6.1.2 – 6.1.3)
- Classification of walls with respect to reaction to fire, including test method used, when relevant (Clause 6.2.1)
- Classification of walls with respect to fire resistance, including test method used, when relevant ; material characteristics relating to possible application of Annex C, when relevant (Clause 6.2.2)
- Statement on the presence and concentration/emission rate/etc. of formaldehyde, asbestos and other dangerous substances or statement confirming no presence of dangerous materials (Clause 6.3.1).
  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.”
- Indication of water vapour permeability of materials (Clause 6.3.2)
- Statement that condensation in the wall as a result of water vapour diffusion will not occur or will occur only to an extent where damage is not caused during the condensation period and that the wall will dry out again (Clause 6.3.3)
- Description of the nature of the incorporated finishes using precise specifications or stating compatible types (clause 6.7)
- Indication of measured airborne sound insulation, including the test method used (Clause 6.5.1) when relevant
- Indication of measured sound absorption coefficient, including the test method used (Clause 6.5.2) when relevant
- Indication of calculated or measured thermal resistance, including the calculation or test method used (Clause 6.6.1)
- Indication of that any moisture accumulation in the wall is harmless (6.6.2)
- Indication of relevant data for the calculation of the contribution to the thermal inertia of the works (Clause 6.6.3)
- Indication of resistance to deterioration (clause 6.7.1), including test method, if used, under action of physical agents with indication of the temperature range for which the kit has been assessed (clause 6.7.1.1), chemical agents (corrosion, cleaning agents, clause 6.7.1.2) and biological agents (clause 6.7.1.3) and resistance to normal use damages (clause 6.7.2).

9.2 ADDITIONAL INFORMATION

It shall be stated in the ETA that the manufacturer’s installation guide forms a supporting document for the ETA, see clause 7.2 of this Guideline,

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

ANNEX A

COMMON TERMINOLOGY AND ABBREVIATIONS

A.1. WORKS AND PRODUCTS

A.1.1. *Construction works (and parts of works)* (often simply referred to as "works") (ID1.3.1)

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).

A.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, components of prefabricated systems or installations.)

A.1.3 *Incorporation* (of products in works) (ID 1.3.1)

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.

A.1.4 *Intended use* (ID 1.3.4)

Role(s) that the product is intended to play in the fulfilment of the essential requirements.

A.1.5 *Execution* (ETAG-format)

Used in this document to cover all types of incorporation techniques such as installation, assembling, incorporation, etc…

A.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.

A.2 Performances

A.2.1 *Fitness for intended use* (of products) (CPD 2.1)

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.

A.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 foreseeable actions (CPD Annex I, Preamble).

A.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).

A.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).

A.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.

A.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.

A.3 ETAG-format

A.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.

A.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.)

A.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.

A.4 Working life

A.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.

A.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.

A.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.

A.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 fulfill all its functions during its working life. These measures include cleaning, servicing, repainting, repairing, replacing parts of the works where needed, etc.

A.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.

A.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.

A.5 Conformity

A.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.

A.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.

A.6 APPROVAL AND APPROVED BODIES

A.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.

A.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

A.7 Abbreviations

A.7.1 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 Standards
FPC : Factory production control
ID : Interpretative documents of the CPD
ISO : International Standardisation Organisation
SCC : Standing Committee for Construction of the EC.

A.7.2 Abbreviations 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

A.7.3 General abbreviations:

WG : Working Group.

ANNEX B

DESIGN METHODS FOR GRID TYPE SHEAR WALLS

NOTE :

It is reminded that assessing the shuttering kit/system does not include assessing the concrete structure, which is the designer's job. The basic assumption for granting an ETA is that the shuttering kit/system is compatible with the design of the concrete structural pattern according to ENV 1992-1-1 : 1991 and ENV 1992-1-6 : 1994 (see 7.2.2).

As there is no specific method in ENV 1992-1-1 :1991 AND ENV 1992-1-6 :1994, for the structural analysis of walls with grid type structural pattern, loaded in plane by shear forces, this Annex gives hereafter a proposal derived from theses ENV excepted for a recommended safety factor.

On the other hand, it is pointed out that the design method of Clause A cannot be used for applications in seismic zones where national provisions do not allow for the tensile strength of concrete to be taken into account. For these applications tensile members have to be verified according to ENV 1998 (earthquake resistant structures), or current national codes.

Three load bearing models according to Figure 1 may be applied:

- frame model (plain concrete)
- continuous strut model (plain concrete)
- beam model (reinforced concrete)

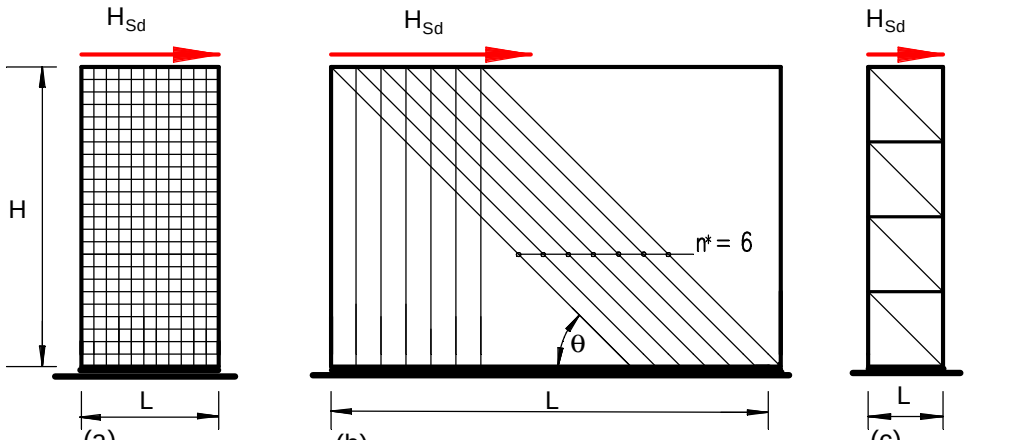

Figure 1: Load bearing models for horizontal shear forces H_{Sd}

The design resistance of the proposed design models may be determined according to the following approaches:

A. Frame model

The design resistance $H_{Rd,1}$ of the frame model depends on the tensile strength of the connecting beams (connectors). Assuming a parabolic shear stress distribution over the wall length L according to beam theory and assuming a zero point of moment at mid-span of the connectors the load carrying capacity of a connecting beam is reached when the tensile stress due to the maximum bending moment at the intersection connector/column exceeds the flexural tensile strength of concrete. The maximum value of the shear stress H'_{Sd} is given by Equ (1):

$$\max H'_{Sd} = \frac{3}{2}\frac{H_{Sd}}{L}, \qquad \text{... (1)}$$

thus leading to a maximum shear force $\max V_{Sd,r}$ in a connector

$$\max V_{Sd,r} = H'_{Sd} \cdot h_s = \frac{3}{2}\frac{H_{Sd}}{L} h_s \qquad \text{... (2)}$$

The adjacent maximum bending moment $\max M_{Sd,r}$ in a connector is

$$\max M_{Sd,r} = \max V_{Sd,r} \cdot \frac{l_r}{2} = \frac{3}{4}\frac{H_{Sd}}{L} h_s l_r \qquad \text{... (3)}$$

With a given section modulus Z_r of the connector and a given flexural tensile strength $f_{ctk,fl}$ the design resistance of a wall yields to:

$$H_{Rd,1} = \frac{4}{3}\frac{L}{h_s}\frac{Z_r}{l_r}\frac{f_{ctk,fl}}{\gamma_{ct}} \qquad \text{... (4)}$$

In Equ (4) the following notations apply (compare Figure 2):

$H_{Rd,1}$	design shear resistance according to the frame model
L	wall length
h_s	distance between connectors axis
l_r	clear width of a connector
Z_r	section modulus of a connector
$f_{ctk,fl} = 0.42 f_{ck}^{2/3}$ [MN/m²]	
$f_{ctk,fl}$	characteristic flexural tensile strength of concrete
f_{ck}	characteristic compressive strength of concrete (cylinder)
γ_{ct}	safety factor for tensile strength of concrete

It is recommended to apply

γ_{ct} = 3.00

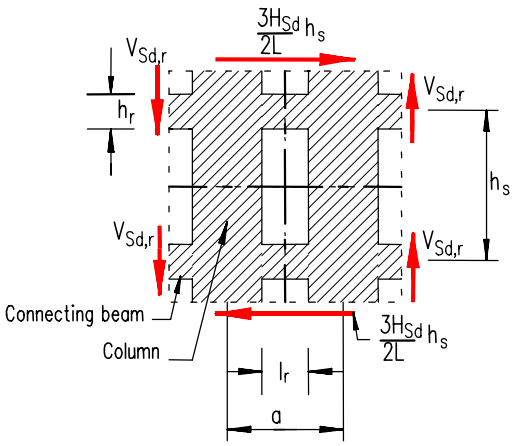

Figure 2: Notations

B. Continuous strut model

The design resistance $H_{Rd,2}$ of the continuous strut model depends on the strength of the *n* struts passing continuously from one storey to the next one through the wall (compare Figure 1 and 3).

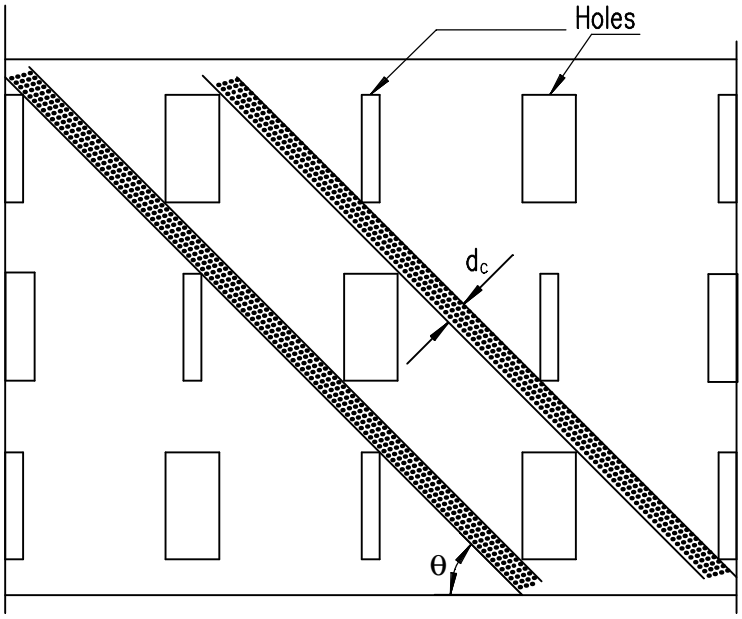

Figure 3: Depth d_c of a continuous strut

The design resistance of a strut is determined acc. to ENV 1992-1-1:1991, clause 4.3.2, where a reduction factor ν is to be taken into account. The angle of inclination θ of the struts follows from Figure 3.

The design resistance $H_{Rd,2}$ is given by Equ (6):

$$H_{Rd,2} = n^* \nu f_{cd} b_c d_c \cos\theta \quad \text{....(6)}$$

$H_{Rd,2}$	=	design shear resistance according to the continuous strut model
n^*	=	quantity of continuous struts in a wall
f_{cd}	=	design strength of concrete in compression
ν	=	$0.70 - f_{ck}[MN/m^2]/200 \geq 0.50$ (equ. 4.21 in ENV 1992-1-1 :1991)
b_c	=	width of a strut
d_c	=	height of a strut (7 cm minimum)
θ	=	angle of inclination of the struts $30° \leq \theta \leq 60°$

C. Beam model

The design resistance $H_{Rd,3}$ according to the beam model can be determined with the help of the design rules valid for reinforced concrete beams; the links are represented by horizontal bars passing along the connectors. A sufficient end anchorage of the horizontal bars – e.g. by hoop reinforcement – has to be verified according to ENV 1992-1-1:1991, clause 5.2.

The design resistance $H_{Rd,3}$ is given by Equ (7):

$$H_{Rd,3} = A_{sh,r}\, f_{yd} \quad \text{... (7)}$$

$H_{Rd,3}$ = design shear resistance according to the beam model

$A_{sh,r}$ = horizontal reinforcing bars (links) section

f_{yd} = design strength of steel

The stability under horizontal shear forces is given if:

$$H_{Sd} \leq H_{Rd} \quad \text{... (8)}$$

Under a combined design action of horizontal and vertical loads the columns have to remain in stage I i.e. no tensile stress should occur, otherwise tensile vertical reinforcing bars in the columns have to be used by the designer.

ANNEX C

RESISTANCE TO FIRE
Minimum dimensions of concrete infill

This annex is derived from ENV 1992-1-2:1995 – Eurocode 2 : Design of concrete structures – Part 1-2 : General rules – Structural fire design.
It is a proposal for the attention of the Approval bodies in view of a common approach for a tentative classification of walls, the organisation of which meet some particular reported requirements and based on the geometry of the infilled concrete structure in case of lack of fire resistance test data to be reported in the ETA.
The resistance to fire of a wall, the minimum dimensions of the concrete infill corresponding to criteria of duration of resistance to fire are given in the following tables 1 and 2, in the general case of a wall exposed on one side.

The following preconditions have to be fulfilled.

- **Design**

  The design of the building has to take into consideration the secondary effects of fire. Especially constraints, introduced by thermal strain, should be sufficiently low and appropriate building joints should be foreseen. The rules, valid in place of use, govern.

  Structural requirements on work in normal conditions, valid in the place of use, may require larger dimensions. Concrete cover for the reinforcement has to be observed according to the rules valid in the place of use.

- **Concrete**

  A normal weight concrete as defined in prEN 206-1-2000 Concrete - Part 1 : *Specification, performance, production and conformity* or ENV 1992-1-1:1991 Eurocode 2 : *Design of concrete structures - Part 1 : General rules and rules for buildings* shall be used. As far as European standards EN 206 or EN 1992-1-1 are not inforce, an equivalent concrete according to national rules, valid in the place of use, is acceptable.

- **Strength of concrete**

  The strength of concrete shall be between C16/20 and C50/60 according to prEN 206. In lack of availability of European standard EN 206, alternatively a concrete according to national rules, valid in the place of use, with a compressive strength which fits in the interval given above, is also considered as appropriate.

- **Grid and column**

  In case of hollow blocks, the blocks shall on both sides either be plastered/rendered or at least the joints on both sides shall be sealed with plastering/rendering mortar. The mortar for plastering/rendering or for sealing shall be based on inorganic aggregates, gypsum, cement or lime or on suitable combinations of these three binders.

- **Specifications for materials of shutterings in case of grid and column type wall to apply table 1**

  In this case, the assumption of the wall being fire exposed on one side is only applicable when one of the following conditions is fulfilled :
  - the spacers are made of a material with a reaction to fire performance of class A without testing, (see Commission Decision 96/603/EC) or class A1 or class A2 and do not melt at a temperature less than 1000°C.
  - the spacers are made of materials of classes B and C and the concrete grid is covered in end use conditions by materials of class A1, A2, B or C, additionally the materials of spacers and cover are known to perform adequately in fire conditions, which especially means, the materials do not melt at a temperature less than 1000°C and they do not show a high charring rate (more than 0,7 mm per minute). In addition when the thermal conductivity of the spacers is more than the thermal conductivity of a normal weight

concrete, heat transfer calculation should be made to evaluate the temperature on the side opposite to fire.

Table 1 : Minimum thickness of the concrete infill in the case of wall exposed on one side

	Continuous type load bearing wall	Continuous type non load bearing wall	Grid and column type load bearing wall
Criteria	REI	EI	REI
Duration (minutes)	minimum thickness of the concrete infill (mm)		minimum dimension of concrete columns (mm)
30	100	90	100
60	110	90	120
90	120	100	150
120	150	120	170

- **Spécifications for materials of shutterings in case of grid and column type wall to apply table 2**

In the case where the specifications for applying table 1 are not fulfilled (melting or easy burning shuttering material) the columns are considered to be exposed on more than one side and the minimum dimension of such columns is given in table 2 :

Table 2 : Grid and column type load bearing walls, minimum dimension of vertical columns

Criteria	R
Duration (minutes)	Minimum dimension of concrete columns (mm)
30	150
60	200
90	240
120	280

Limitations

a) Non load-bearing wall

The ratio of clear height of wall *lw* to concrete thickness *t* should not exceed :

- 40 in case of non load-bearing wall and EI duration criteria less or equal to 60 minutes and,
- 25 in case of EI duration criteria more or equal to 90 minutes.

b) Load-bearing wall

The μ_{fi} value, according to ENV 1992-1-1:1991-, shall not exceed 0,7.

The slenderness of the concrete infill shall not exceed 50.

ANNEX D

List of reference documents

ETAG 003:1999, *Internal Partition Kits*

ETAG 004:March 2000, *External thermal Insulation Composite Systems*

prEN 206-1:2000, *Concrete* – Part 1 : *Specification, performance, production and conformity*

ENV 1992-1-1:1991, *Eurocode 2 : Design of concrete structures*
Part 1-1 : G*eneral rules and rules for buildings*

ENV 1992-1-6:1994, *Eurocode 2 : Design of concrete structures*
Part 1-6 : G*eneral rules – Plain concrete structures*

ENV 1995-1-2:1995, *Eurocode 2: Design of concrete structures. Part 1-2: General rules Structural Fire design*

EN 1363-1:1999, *Fire resistance tests* - Part 1 : *General requirements*

EN 1363-2:1999, *Fire resistance tests* - Part 2 : *Alternative and additional procedures*

EN 1365-1:1999, *Fire Resistance Tests for loadbearing elements*- Part 1 : *Walls*

EN 1364-1:1999, *Fire resistance tests for non-loadbearing elements* – Part 1 : *Walls*

prEN 1364-3:1999, *Fire resistance tests for non-loadbearing elements*
Part 3 : Curtain walling, full configuration

EN 12086:1997, *Thermal insulating products for building applications – Determination of water vapour transmission properties*

prEN ISO 12572, *Hygrothermal performance of building materials and products – Determination of water vapour transmission properties*" (ISO/DIS 12572:1997).

EN 1015-12:2000, *Methods of test of mortar for masonry* –Part 12 : *Determination of adhesive strenght of hardened rendering and plastering mortar on substrate*

EN 1607 : 1996/AC : 1997, *Thermal insulating products for building applications - Determination of tensile strength perpendicular to faces*

prEN 13168, *Thermal insulation products for buildings. Factory made products of Wood Wool and Wood wool composite slabs (ww) - Specification*

M.O.A.T 43:1987, UEAtc *Directives for Impact Testing Opaque Vertical Building Components.*

EN ISO 140-3:1995, *Acoustics – Measurement of sound insulation in buildings and of building elements* – Part 3 : *Laboratory measurements of airborne sound insulation of building elements*.

EN 12354: 2000, *Building acoustics - Estimation of acoustic performance of buildings from the performance of elements* (Parts 1 and 3)

EN ISO 354:1993, *Acoustics – Measurement of sound absorption in a reverberation room* (ISO 354:1985)

EN ISO 354/A1:1997, *Acoustics – Measurement of sound absorption in a reverberation room* – Amendment 1: *Test specimen mountings for sound absorption tests*

EN 12524:2000, *Building material and products – Hygrothermal properties – Tabulated design values*

EN ISO 6946:1996, *Building components and building elements – Thermal resistance and thermal transmittance – Calculation method* (ISO 6946:1996)

EN ISO 8990:1996, *Thermal Insulation – Determination of steady-state thermal transmission properties – Calibrated and guarded hot box* (ISO 8990:1994).

ISO 8301:1991, *Thermal insulation – Determination of steady-state thermal resistance and related properties – Heat flow meter apparatus*

ISO 8302:1991, *Thermal insulation – Determination of steady-state thermal resistance and related properties – Guarded hot plate apparatus*

EN ISO 10456: 1999, *Building materials and products – Procedure for determining declared and design*

thermal values

prEN ISO 13788, *Hygrothermal performance of building components and building elements - Estimation of internal surface temperature to avoid critical surface humidity and calculation of interstitial condensation (ISO/DIS 13788:1997).*

EN 423: 1993, *Resilient floor coverings – Determination of the effect of stains*

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

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

EN ISO 717-1:1996, *Acoustics – Rating of sound insulation of buildings and in building elements*
Part 1 : *Airborne sound insulation (ISO 717-1:1996).*

EN ISO 11654: 1997, *Acoustics – Sound absorbers for use in buildings – Rating of sound absorption*.

EN 335-1:1992, *Durability of wood and derived materials - Definition of hazard classes of biological attacks* - Part 1 : *General*

EN ISO 10211-1:1995, *Thermal bridges in building constructions –Heat flows and surface temperatures* – Part 1: *General calculation methods* (ISO 10211-1:1995)

EN ISO 10211-2:1995, *Thermal bridges in building constructions – Calculation of Heat flows and surface temperatures* – Part 2 : *linear thermal bridges*.