EUROPEAN ASSESSMENT DOCUMENT

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

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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1 SCOPE OF THE EUROPEAN ASSESSMENT DOCUMENT

1.1 Description of the construction product

This European Assessment Document (EAD) applies to non-load bearing permanent shuttering kits/systems based on hollow blocks or panels of thermal insulating material and sometimes concrete.

For the purposes of this EAD, the kit is considered to be made of 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 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-wool, mineral wool. After assembling, the blocks or panels are filled in situ with concrete, with or without reinforcement.

Common finishes to the walls such as rendering, cladding, plastering or dry-lining are not part of the kit, if they are applied on site.

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.

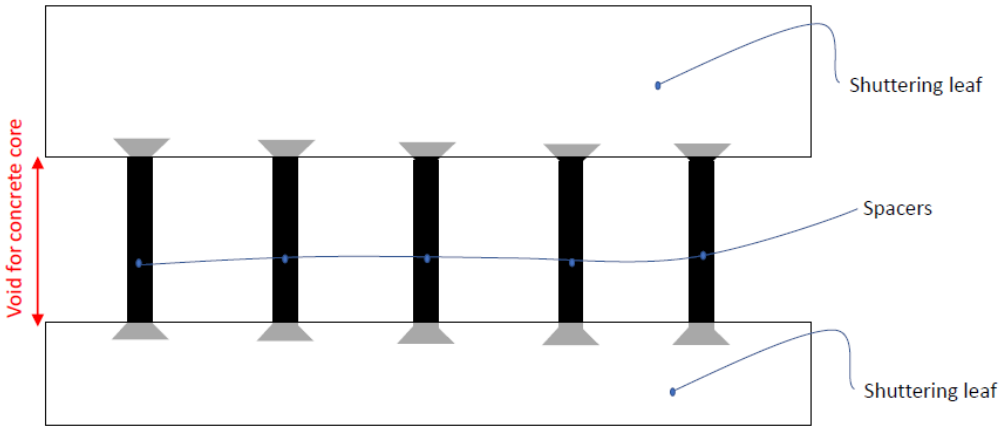

Figure 1.1.1 Panel shuttering kit/system

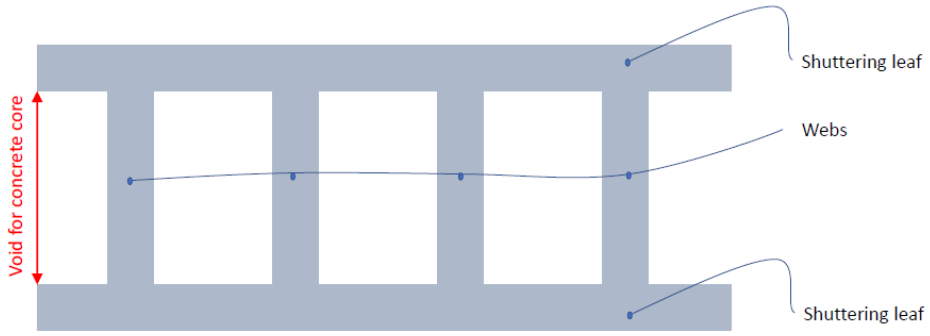

Figure 1.1.2 Hollow block shuttering kit/system

The shuttering leaves or at least one of them are intended 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.

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.

The product is not fully covered by the harmonised technical specifications.

- EN 15498 Precast concrete products – Wood-chip concrete shuttering blocks – Product properties and performance.
- EN 15435 – Normal weight and light weight concrete shuttering blocks

The differences of the EAD to these hENs are the followings:

i) In the hENs are only considered essential characteristics that relate to the individual blocks and not to essential characteristics of the walls which are to be built with them and depend on the characteristics of the blocks. These are the following essential characteristics of the EAD:

2.2.1 Resulting structural pattern

2.2.2 Efficiency of filling

2.2.3 Possibility of reinforcement

2.2.5 Influence of the shuttering kit on the fire resistance

2.2.11 Resistance to impact load

2.2.17 Thermal inertia

2.2.18 Resistance to deterioration

ii) In the hENs only one type of the possible shuttering kits/systems based on hollow blocks (see figure 1.1.2) and only one of the possible materials (normal weight or light weight concrete in EN 15435 and wood-chip concrete in EN 15498) are considered.

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

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

Relevant manufacturer's instructions having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

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

1.2.1 Intended uses

The intended use of non-load bearing permanent shuttering kits/systems based on hollow blocks or panels of thermal insulating material and sometimes concrete, with or without steel reinforcement, is to construct walls. The finished walls can be load-bearing or non-load bearing and external or internal. The walls can be also adopted for buildings in seismic areas. The kit is intended for indirect contact to soil, ground- and surface water.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based upon the assumed intended working life of the shuttering kit for the intended use of 50 years (provided that the shuttering kit is subject to appropriate installation (see 1.1).

When assessing the product the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic characteristics for works[1].

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

1.3 Specific terms used in this EAD

1.3.1 General

- Component: A component is a single part of the shuttering kit.
- ETICS: External thermal insulation composite systems with rendering.
- 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.
- 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.
- Shuttering leaves: Vertical components of the shuttering kit; see figure 1.1.1 and figure 1.1.2
- 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; see figure 1.1.1.
- Thermal insulation of a shuttering kit: The thermal conductivity (λ value) of the incorporated insulating material should not exceed 0,5W/m.K.
- Webs: In the case of single-material shuttering blocks, spacers are made of the same material as shuttering leaves, they are called “webs”; see figure 1.1.2.
- Shuttering wall: Shuttering blocks or elements assembled to a shuttering for the complete concrete wall according to the installation instructions of the manufacturer.

1.3.2 Wall 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.

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

1.3.3 Wall 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.

1.3.4 Shuttering element types:

- Hollow blocks :
  Shuttering elements, the dimensions of which are 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 one-floor-high.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

All undated references to standards or to EADs in this document are to be understood as references to the dated version listed in Chapter 4.

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of the Non load-bearing permanent shuttering kits/systems based on hollow blocks or panels of insulating materials and sometimes concrete is assessed in relation to the essential characteristics.

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

No	Essential characteristic	Assessment method	Type of expression of product performance
Basic Works Requirement 1: Mechanical resistance and stability			
1	Resulting structural pattern	2.2.1	Description
2	Efficiency of filling	2.2.2	Description
3	Possibility of steel reinforcement	2.2.3	Description
Basic Works Requirement 2: Safety in case of fire			
4	Reaction to fire	2.2.4	Class
5	Influence of the shuttering kit on the fire resistance	2.2.5	Class
Basic Works Requirement 3: Hygiene, health and the environment			
6	Content, emission and/or release of dangerous substances	2.2.6	Description
7	Water vapour permeability	*2.2.7*	Level
8	Water absorption	2.2.8	Level
9	Water tightness	2.2.9	
Basic Works Requirement 4: Safety and accessibility in use			
10	Bond strength	2.2.10	Description
11	Resistance to impact load	2.2.11	Description
12	Resistance to filling pressure	2.2.12	Description
13	Safety to personal injuries	2.2.13	Description
Basic Works Requirement 5: Protection against noise			
14	Airborne sound insulation	2.2.14	Level
15	Sound absorption	2.2.15	Level
Basic Works Requirement 6: Energy economy and heat retention			
16	Thermal resistance	2.2.16	Level
17	Thermal inertia	2.2.17	Level
Aspects of durability			
18	Resistance to deterioration	2.2.18	Description

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

Testing will be limited only to the essential characteristics which the manufacturer intends to declare. If for any components covered by harmonised standards or European Technical Assessments the manufacturer of the component has included the performance regarding the relevant characteristic in the Declaration of Performance, retesting of that component for issuing the ETA under the current EAD is not required.

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

2.2.1 Resulting Structural Pattern

When the manufacturer intends to declare performance related to “Resulting Structural Pattern” the ETA shall describe the product as follows:

-The type of structural pattern shall be identified by visual inspection based on definitions given in 1.3.3;

-The dimensions of the voids determining the structural pattern of the concrete in-fill shall be identified by visual inspection of the product;

-The dimensional tolerances of the product shall be identified;

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

2.2.2 Efficiency of filling

The efficiency of filling shall be determined by erection of a trial structure, realized in accordance with the manufacturer’s instructions including method of placement of the shuttering kits, filling concrete characteristics (minimum strength, consistency, maximum aggregate size…) and methods of concreting (height of pouring, maximum height of filling, method of filling…).

If the manufacturer’s installation instructions allow the possibility to use a range of consistency class, the lower end of the range (stiffer concrete) shall generally be used for the efficiency of filling assessment.

The trial structure shall include as many typical details as possible, for example, if appropriate for the kit : corners; window openings and/or door openings; 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:

1) Tightness:

Joints and details shall be inspected to determine any loss of fines. If any, the leakage observed shall be described in the ETA.

2) Completeness of filling:

An indication of completeness of fill may be obtained by observing the presence of cement grout 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 EN 206* and be compared to the strength of plain, correctly compacted areas of wall to determine any effects on properties.

3) 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.

2.2.3 Possibility of steel reinforcement

If the steel reinforcement is used and the manufacturer intends to declare performance related to “Possibility of steel reinforcement” the following shall be stated in the ETA:

-The possibility of steel reinforcement assessed by visual inspection;

-The minimum required reinforcement shall be assessed by visual inspection or when necessary by practice tests.

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, the description of the specific configuration shall be given in the ETA.

Additional structural reinforcements, especially those required for building in seismic areas (intermediate vertical and horizontal links) shall be stated in ETA, in terms of: i) number of longitudinal steel bars and transversal stirrups/legs, ii) diameter of the longitudinal and transversal reinforcement, iii) adopted spaces and covers. Intended use for the additional reinforcement (i.e seismic reinforcement) shall be stated in ETA. 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.

2.2.4 Reaction to fire

The product shall be tested according to the test methods referred to in EN 13501-1* and classified according to the Commission Delegated Regulation (EU) No 2016/364.

In all cases the layers susceptible to be involved in fire situation shall be tested for classification.

Note: A European reference fire scenario has not been laid down for façades. In some Member States, the classification of the product as above might not be sufficient for the use in façades. An additional assessment according to national provisions (e.g. on the basis of a large scale test) might be necessary to demonstrate the compliance with Member State regulations or administrative provisions.

2.2.5 Influence of the shuttering kit on the fire resistance

The resistance to fire of a wall realized with the product shall be assessed by testing or in accordance with Annex A[2]. Testing is the reference method.

2 TABs shall inform manufacturers that the evaluation of the behavior to fire through the calculation presented in Annex A could not be accepted in some Member States.

For load-bearing walls, testing is performed as described through the standards EN 1363-1*, EN 1363-2* and EN 1365-1* for the corresponding resistance to fire class according to EN 13501-2*.

For non-load-bearing walls, testing is performed as described through the standards EN 1363-1, EN 1363-2 and EN 1364-1* for the corresponding resistance to fire class according to EN 13501-2*.

All boundary conditions which affects fire resistance of the wall including concrete core shall be stated in the ETA:

- Type and strength of concrete (EN 206);
- Reinforcement;
- Dimensions;
- Type of load and load-level (-> determination of test load shall be given in the EAD);
- Utilization ratio (-> determination of utilization ratio shall be given in the EAD);
- Eccentricity of load;
- Details of construction (e.g. connection to adjacent construction parts which affect the system to be considered, finishing…).

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 EN 1992-1-2*. As the transposition of the tables given in this reference document needs some interpretation, a common approach is reported in Annex A for the attention of the Technical Assessment Bodies.

2.2.6 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer[3] after identifying the release scenarios (in accordance with EOTA TR 034) taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market. The identified intended release scenarios for this product and intended use with respect to dangerous substances are:

IA3: Product with no contact to indoor air

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

S/W3: Product with no contact to soil, ground- and surface water

For the intended use covered by the release scenario S/W2, the performance of the product concerning leachable substances has to be assessed.

<u>For blocks or panels made of concrete or clay:</u>

A leaching test with subsequent eluate analysis must take place, each in duplicate. Leaching tests of the blocks or panels are conducted according to CEN/TS 16637-2:2014. The leachant shall be pH-neutral demineralised water and the ratio of liquid volume to surface area shall be (80 ± 10) l/m².

Samples shall be prepared in accordance with clause 8.2 of CEN/TS 16637-2:2014.

The eluates taken after 6 hours, 1 day, 2 days and 6 hours, 4 days, 9 days, 16 days, 36 days and 64 days shall be analysed for following environmentally relevant parameters:

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3 The manufacturer may be asked to provide to the TAB the REACH related information which he must accompany the DoP with (cf. Article 6(5) of Regulation (EU) No 305/2011).

The manufacturer is **<u>not</u>** obliged:
- to provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- to provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous according to Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS.

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

- antimony, arsenic, barium, lead, cadmium, chromium (total), chromate (Cr VI), cobalt, copper, molybdenum, nickel, mercury, thallium, vanadium, zinc,
- chloride (Cl^-), sulfate (SO_4^{2-}), fluoride (F^-)
- TOC,
- pH-value, electrical conductivity, odour, colour, turbidity, and tendency to produce foam

The parameters shall be analysed with an appropriate standardised test method (this test method shall have a suitable method detection limit compared to the limit value).

Measured concentration of the leaching test in accordance with CEN/TS 16637-2:2014 of hardened concrete must be expressed per step for each parameter in µg/L and mg/m^2. Additionally, the cumulatively released quantities must be expressed for each parameter in mg/m^2.

The used test methods for the analysis of the parameters shall be documented including method detection limits.

Note: For materials other than concrete or clay, no tests shall be carried out. As for these materials at present there are no European assessment methods for leaching assessment or the scenario S/W 2 does not apply.

2.2.7 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 and intended use. In situations where properties such as water vapour permeability are not known, they shall be determined by testing.

For thermal insulating products, testing of the water vapour permeability of materials is performed as described in EN 12086*.

For materials different from thermal insulating products, EN ISO 12572* may be used.

The water vapour resistance factor shall be stated in the ETA.

2.2.8 Water absorption

For thermal insulating products, EN ISO 16535* shall be used.

Plastic material is tested according to EN ISO 62, method 1. Water saturation is attained as soon as the absolute value of the difference in mass is within 0.2 mg within 3 successive weightings.

For concrete blocks, the water absorption coefficient according to EN 772-11 and EN 771-3 is determined.

If finishes are incorporated in the kit, water absorption of finishes shall be assessed according to EAD 040083-00-0404, 2.2.5.1.

2.2.9 Water-tightness

If finishes are incorporated in the kit water-tightness shall be assessed according to EAD 040083-00-0404, 2.2.6 and 2.2.7.

2.2.10 Bond strength

The bond strength of the shuttering can be governed by:

- Bond strength between layers of a shuttering leaf;

- Bond strength between shuttering leaf and concrete.

2.2.10.1 Bond strength between layers of a shuttering leaf

Basis for the assessment procedure is EN 1607 with the following modifications:

The specimens according to EN 1607, 6.1, are the multilayer shuttering leaves according to the description of the assessed shuttering kit/system. The thickness of the test specimens corresponds (vertical direction according to EN 1607 Figure 1) to the thickness of the respective multilayer shuttering leaf.

At the time of writing this EAD, three types of connections between layers of shuttering leaves were known:

- glued to the surface (see e.g. Figure 2.2.10.1.1a),
- mechanical interlocked (see e.g. Figure 2.2.10.1.1b).
- mechanical interlocked and glued to the surface (see e.g. Figure 2.2.10.1.1c).

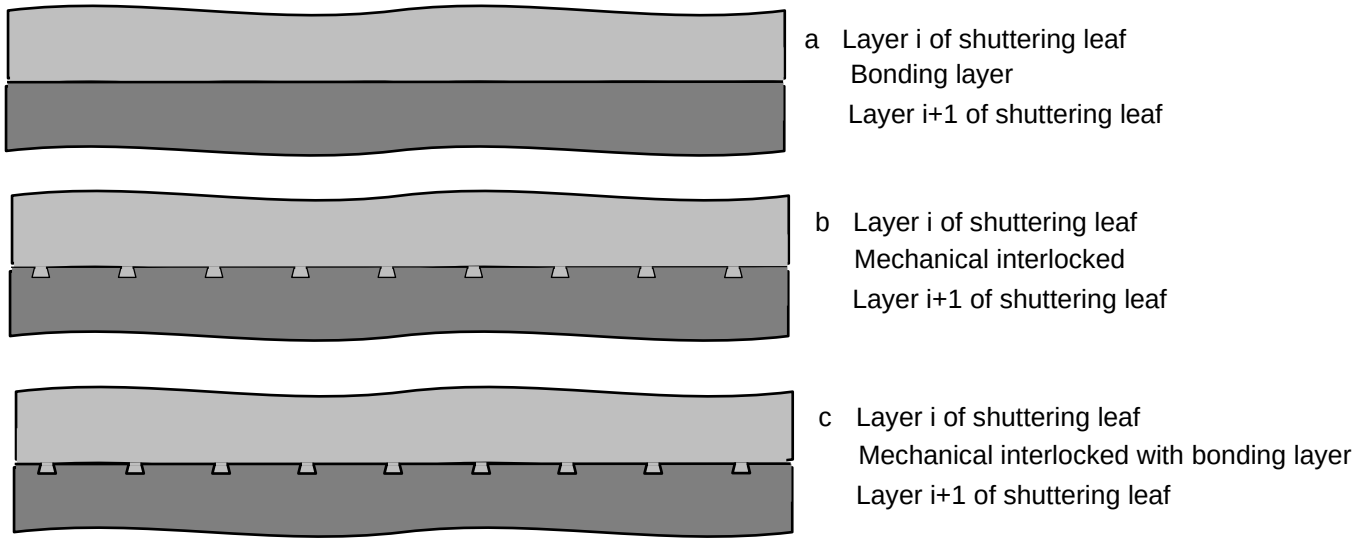

Figure 2.2.10.1.1 Connections between layers of the shuttering leaves

2.2.10.2 Bond strength between shuttering leaf and concrete

Usually the connection between spacers and shuttering leaves is sufficient for the bond between concrete and shuttering leaves. If the applicant also wants to consider the bond between the concrete and the layer of the shuttering leaf which is in direct contact with the concrete, this is possible as follows:

The specimens according to EN 1607, 6.1, are the layer of the shuttering leaf which according to the description of the assessed shuttering kit/system is in direct contact to the concrete and a layer of concrete with the minimum thickness of the concrete core of the assessed shuttering kit/system.

At the time of writing this EAD, three types of connection between the concrete and the layer of the shuttering leaf which is in direct contact to the concrete were known:

- adhesive bond between concrete and layer of shuttering leaf which is in direct contact with the concrete (see e.g. Figure 2.2.10.2.1a),
- mechanical interlocked and adhesive bond between concrete and layer of shuttering leaf which is in direct contact with the concrete (see e.g. Figure 2.2.10.2.1b).

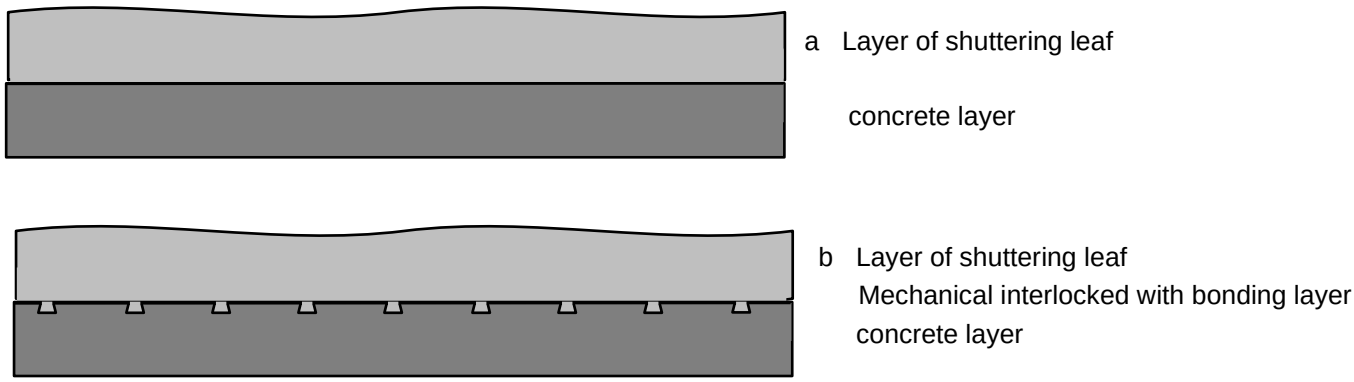

Figure 2.2.10.2.1 Connections between concrete and the layer of the shuttering leaf which is in direct contact with the concrete

If the applicant does not want to consider the adhesive bond to the concrete in the case of a mechanical interlocked connections to the concrete, it is also possible to determine the bond strength to the concrete by calculation. Therefore, the tensile strength perpendicular to the surface σ_{mt} of the layer of shuttering leaf which is in direct contact to the concrete, shall be known or determined according to EN 1607. Afterwards the bond strength of the connection between concrete and shuttering leaf may be determined as follows:

$$\sigma_{mt,csl} = \frac{\sigma_{mt} A_{ml}}{A},$$

Where

A mm² is the section of the specimen according to EN 1607, section 8,

A_{ml} mm² is the section of mechanical interlocked connection over which the tensile force is transmitted perpendicular to the plane of the layer of the layer of shuttering leaf,

σ_{mt} MPa is the tensile strength perpendicular to the surface of the layer of shuttering leaf according to EN 1607.

σ_{mt}cls MPa is the bond strength of the connection between concrete and shuttering leaf.

2.2.11 Resistance to impact load

- Global resistance

The resistance to impact load of the wall is normally governed by the concrete infill (concrete sections, concrete resistance, reinforcement, distance between grid or columns members where relevant, …).

The concrete infill generally provides for the safety resistance of the completed wall under impact loads.

However, an assessment can be made by testing with a large soft body impactor as described in Annex B, energy to be applied is 400 J.

- Local behaviour:

The only risk is that of shuttering fragments detaching and falling over in the case of hard and soft body impact load. Resistance to this type of load is only assessed for incorporated finishes.

Testing of shuttering systems in intended use with respect to impacts from a small hard body and a small soft body is performed as described in Annex B.

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).

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

2.2.12 Resistance to filling pressure.

The objective of this assessment method is to determine the performance of the shuttering walls under extreme concreting conditions.

One or both of the following characteristics are determined:

- The maximum deformation of the shuttering leaves.
- The maximum concrete pressure at which failure of the shuttering blocks or shuttering elements occur.

Failure of the shuttering blocks may occur due to:

- inadequate tensile strength of webs;
- inadequate flexural strength of shuttering leaf.

Failure of the shuttering elements with spacers may occur due to:

- inadequate flexural strength of shuttering leaf.
- failure of connection between spacers and shuttering leaf:
    - pull through/pull out load of spacer to leaf connection;
    - shear strength of spacer anchorage (when anchorage is in a cantilever position).

Two types of methods can be used:

- filling test of the complete wall (2.2.12.1);
- calculation assisted by testing (2.2.12.2)

2.2.12.1 Filling test of the complete wall

Purpose of the test:

These tests are intended to determine the maximum deformation of the shuttering leaves by pouring of complete shuttering walls with concrete.

Test method:

Filling test of a trial shuttering wall is performed according to the manufacturer's instruction, under the most extreme filling conditions (lowest thickness of shuttering leaves, highest thickness of concrete core, consistence of concrete, speed of filling…).

The results can apply for thicker shuttering leaves, thinner concrete core, less fluid concrete and lower speed of filling.

If the manufacturer's installation instructions allow the possibility to use a range of consistency class, the higher end of the range (fluid concrete) shall generally be used for the resistance to filling assessment.

The following wall dimensions shall be used: height ≥ 2,8m and wall length ≥ 2,4m.

Test assessment:

The ETA shall state the following information, based on the conditions of the trial test:

- propping system (if relevant),
- thickness of shuttering leaves,
- thickness of concrete core;
- wall height;
- wall length;
- consistency of concrete;
- filling rate;
- maximum deformation of the shuttering wall.

2.2.12.2 Calculation assisted by testing

2.2.12.2.1 Determination of the material strength by testing

In dependence of the type of shuttering element these tests are intended to determine the ultimate pressure from the material strengths of the parts of the shuttering.

2.2.12.2.1.1 Determination of the flexural strength of the shuttering leaves

The test arrangement and procedure shall be in accordance with EN 15498*, Annex C, except for PVC shuttering blocks.
The flexural failure load $P_{f,msd}$ (see EN 15498, C4.3) shall be measured (see EN 15498, Figure C.1). In deviation to procedure as per EN 15498, Annex C, section C.3, the tests shall be carried out path controlled with a constant piston rate of 0,1 mm/s and an accuracy of 1% for the force measurement.
From these measured flexural failure loads the characteristic value P_{fk} shall be determined according to EN 1990* Annex D.7 for unknown variation coefficient.

Testing PVC shuttering blocks shall be performed as per EN ISO 178*:

- specimen according to EN ISO 178*, Clause 6.1.3,
- the number of test specimens is at least 6,

From these measured flexural failure loads the characteristic value P_{fk} shall be determined according to EN 1990* Annex D.7 for unknown variation coefficient to calculate f_{fk}.

The characteristic value of the flexural strength of the shuttering leaves f_{fk} then may be determined by

$$f_{fk} = \frac{P_{fk} * L}{4 * W_1}$$

where W_1 is the moment of resistance of the shuttering leaf which may be determined from the thickness t_1 and the height h_1 of the shuttering leaf by $W_1 = \frac{h_1 * {t_1}^2}{6}$. L is the distance according to EN 15498*, Annex C or in case of PVC shuttering blocks according to EN ISO 178*.

Where

f_{fk}.....MPa ..... Characteristic flexural strength of shuttering leave
h_1 ..... mm..... Height of shuttering leaf
L..... mm..... Distance of support in flexural test
$P_{f,msd}$ ..... N ..... Flexural failure load in test
P_{fk}..... N ..... Characteristic flexural load
t_1 ..... mm..... Thickness of shuttering leaf
W_1 .....mm^3 ..... Moment of resistance of shuttering leaf

For single-element hollow blocks made of lightweight concrete:

- specifying of the characteristic compression strength $f_{ck,cyl}$ for lightweight concrete according to EN 206*.
- determination of the axial tensile strength of the lightweight concrete $f_{ctk;0,05}$ (5% fractile) according to EN 1992-1-1*, Table 11.3.1, as a function of compressive strength $f_{ck,cyl}$ and the minimum dry density of the lightweight concrete.
- taking $f_{f,k} = f_{ctk;0,05}$.

Where

$f_{f,k}$ .....MPa ..... Characteristic flexural strength of shuttering leave

2.2.12.2.1.2 Determination of the tensile strength of the webs

The test arrangement and procedure shall be in accordance with EN 15498*, Annex B.
The web tensile failure loads $P_{t,msd}$ (see EN 15498*, B4.3) shall be measured (see EN 15498*, Figure B.6). In deviation to procedure as per EN 15498*, Annex B, section B.3, the tests shall be carried out path controlled with a constant piston rate of 0,1 mm/s and an accuracy of 1% for the force measurement.
From these measured web tensile failure loads the characteristic value P_{tk} shall be determined according to EN 1990* Annex D.7 for unknown variation coefficient.

Testing PVC shuttering blocks the following deviations shall be applied additionally:

- tests carried out at 23°C and 50% relative air humidity,
- the number of test specimens is at least 10,

From these measured web tensile failure loads the characteristic value P_{tk} shall be determined according to EN 1990* Annex D.7 for unknown variation coefficient to calculate f_{tk}.

The characteristic value of the tensile strength of the webs f_{tk} then may be determined by

$$f_{tk} = \frac{P_{tk}}{A_1}$$

where A_1 is the area of the webs which may be determined from the thickness t_1 and the height h_1 of the shuttering leaf by $A_1 = h_1 * t_1$.

Where

f_{tk}.....MPa ..... Characteristic tensile strength of web
h_1 ..... mm..... Height of shuttering leaf
$P_{t,msd}$ ..... N ..... Tensile failure load in test
P_{tk}..... N ..... Characteristic tensile load
t_1 ..... mm..... Thickness of web
A_1 .....mm^3 ..... Cross-sectional area of web

For single-element hollow blocks made of lightweight concrete:

- specifying of the characteristic compression strength $f_{ck,cyl}$ for lightweight concrete according to EN 206*,
- determination of the axial tensile strength of the lightweight concrete $f_{ctk;0,05}$ (5% fractile) according to EN 1992-1-1*, Table 11.3.1, as a function of compressive strength $f_{ck,cyl}$ and the minimum dry density of the lightweight concrete
- taking f_{tk}= $f_{ctk;0,05}$.
  Characteristic value P_{tk} shall be determined as:
  $P_{tk} = f_{tk} * h_w * t_w$
  Where
  f_{tk}.....MPa ..... Characteristic tensile strength of web
  h_w..... mm..... Height of the recessed web (see EN 15498*, Figure B.6)
  P_{tk}..... N ..... Characteristic tensile load
  t_w..... mm..... Thickness of web

2.2.12.2.1.3 Determination of the pull out load of spacer to leaf connection

Test arrangements and test procedures similar to EN 15498*, Annex B shall be used. The only difference being that the specimens do not contain webs but spacers. In difference to specimens according to EN 15498*, Annex B, it is possible to use specimens which only are connected on one side to the shuttering leaf.

Note: This method is not appropriate for cases were out-of-position anchorage of spacers may occur.

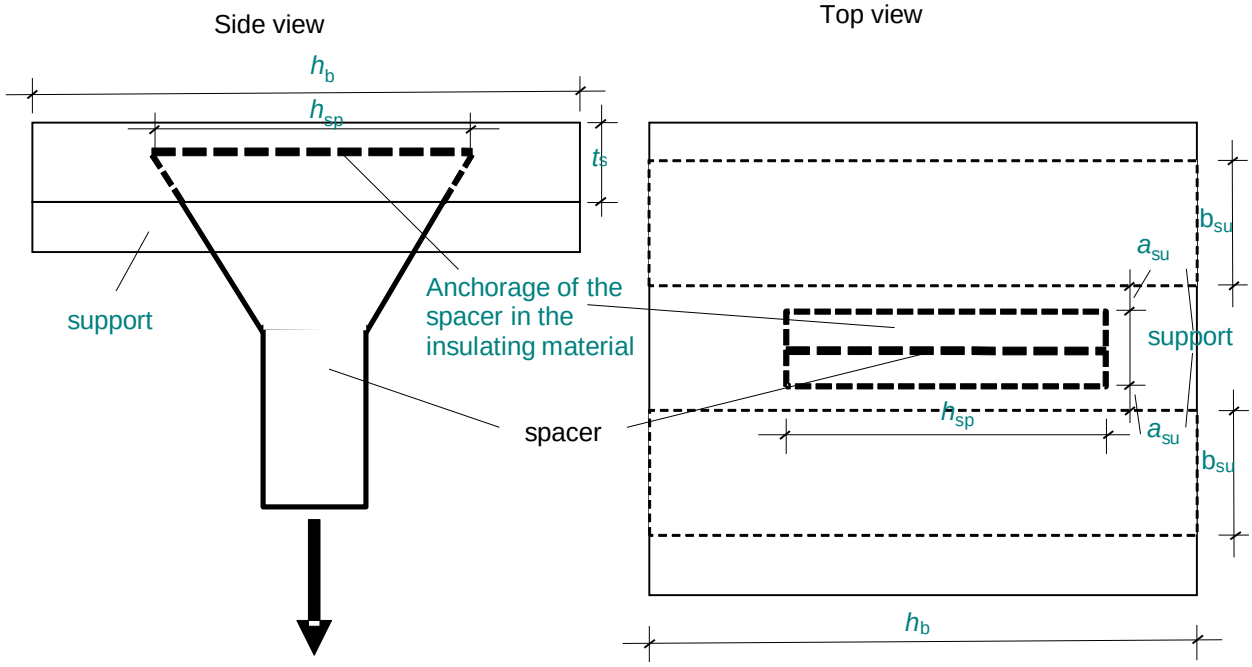

Figure 2.2.12.2.1.3.1: Possible test arrangement with only one side of spacer-leaf connection

Where

t_s..... mm..... thickness of the shuttering leaf
b_{sp} ..... mm..... width of the anchorage of the spacer in the shuttering leaf
h_{sp} ..... mm..... height of the anchorage of the spacer in the shuttering leaf
h_b ..... mm..... height of the shuttering leaf
b_{su} ..... mm..... width of the support of the test arrangement
a_{su} ..... mm..... clearance spacer to support

The minimum value of a_{su} is 2 cm and the minimum value of b_{su} is ¼ a.

At least six test specimens shall be prepared by cutting them from six shuttering elements of the same type and size (for example see 2.2.12.2.1.3.2).

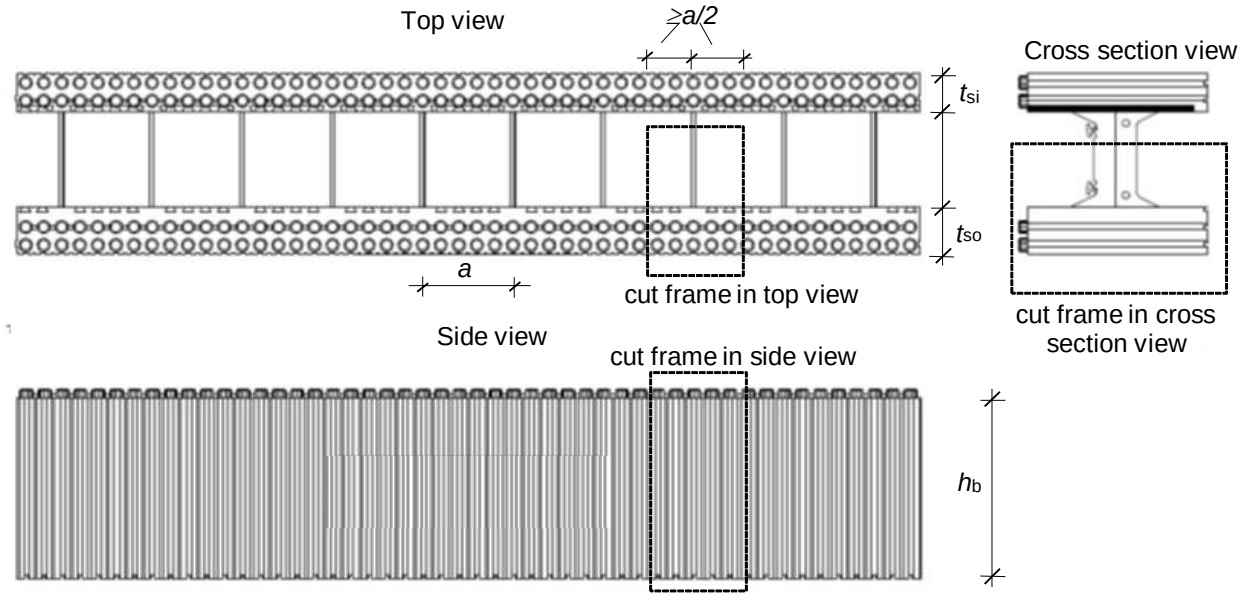

Figure 2.2.12.2.1.3.2: Specimen cut to determine the ultimate bond load between spacer and shuttering leaf

Where

a	mm	maximum distance of the spacers
t_{so}	mm	thickness of the outer shuttering leaf
t_{si}	mm	thickness of the inner shuttering leaf
h_b	mm	height of the shuttering leaf
P_{slu}	N	Pull-out load of spacer in test
P_{slk}	N	Characteristic pull-out load of spacer

The pull out load of spacer P_{slu} shall be determined path controlled with a constant piston rate adjusted to 0.1 mm/min and accuracy of ± 1 % for the force measurement. At least shall be tested 6 specimens.
From these measured pull out loads of spacers the characteristic value P_{slk} shall be determined according to EN 1990* Annex D.7 for unknown variation coefficient.

2.2.12.2.2 Assessment

2.2.12.2.2.1 Assessment for shuttering blocks

The shuttering block resists the concrete pressure p_{max} according to EN 15498*, Annex A if:

- the flexural tensile strength of the shuttering leaf f_{fk} (see 2.2.12.2.1.1) is higher than the flexural stress $\sigma_f(p_{max})$ in the shuttering leaf at the maximum concrete pressure p_{max} according to EN 15498*, Annex A and
- the tensile strength of the web f_{tk} (see 2.2.12.2.1.2) is greater than the tensile stress in the web $\sigma_t(p_{max})$ at the maximum concrete pressure according to EN 15498*, Annex A.

The flexural stress in the shuttering leaf $\sigma_f(p_{max})$ shall be determined as follows:

$$\sigma_f(p_{max}) = \frac{3p_{max} * a^2}{4t_1^2}$$

Where

p_{max}	MPa	is the maximum concrete pressure according to EN 15498*, Annex A,
a	mm	is the length of the hollow core of the shuttering block (see EN 15498*, Figure C.1)
t_l	mm	is the thickness of the shuttering leaf.
σ_f	MPa	is flexural stress in shuttering leaf

The tensile stress in the web $\sigma_t(p_{max})$ shall be determined as follows:

$$\sigma_t(p_{max}) = \frac{p_{max} * h_b}{t_w * h_w}\left(\frac{a_1}{2} + \frac{a_2}{2}\right)$$

Where

p_{max}	MPa	is the maximum concrete pressure according to to EN 15498*, Annex A,
h_b	mm	is the height of the shuttering block,
t_w	mm	is the thickness of the web,

h_w ..... mm..... is the height of the recessed web (see EN 15498*, Figure B.6),

a_1, a_2 .... mm..... are the lengths of the hollow cores left and right to the web (see EN 15498*, Figure B.6).

σ_t.....MPa ..... is tensile stress in web

p_{max} according to EN 15498*, Annex A depends on the thickness of the concrete core t_c (see EN 15498*, Figure A1) and has been determined under the following conditions:

- flow class F4 of the fresh concrete,
- filling height: 2,00 m and
- filling rate of 0,1 m/min.

For higher flow classes, filling heights or filling rates and missing measurement data for the pressure on the shuttering leaves the maximum concrete pressure p_{max} can also be determined on the safe side from the hydrostatic pressure: $p_{max}=\rho_c*g*H$, where ρ_c is the density of the fresh concrete and H the filling height. In most cases g = 9.81 m/s².

Where

p_{max}..... Pa..... Hydrostatic concrete pressure
ρ_c.....kg/m³ ..... Density of fresh concrete
H.....m ..... Filling height
g.....m/s² ..... Gravitational acceleration

2.2.12.2.2.2 Assessment for shuttering elements with spacers

The shuttering element with spacers resists the concrete pressure p_{max} according to EN 15498*, Annex A if:

- the flexural tensile strength of the shuttering leaf f_{fk} (see 2.2.12.2.1.1) is higher than the flexural stress $\sigma_f(p_{max})$ in the shuttering leaf at the maximum concrete pressure p_{max} according to EN 15498*, Annex A and
- the pull out load of spacer P_{slk} (see 2.2.12.2.1.2) is greater than the tensile load in the spacer P_t (p_{max}) at the maximum concrete pressure according to EN 15498*, Annex A

The flexural stress in the shuttering leaf $\sigma_f(p_{max})$ shall be determined as follows:

$$\sigma_f(p_{max}) = \frac{3p_{max} * a^2}{4t_1^2}$$

Where

p_{max}.....MPa ..... is the maximum concrete pressure according to to EN 15498*, Annex A,
a ..... mm..... is the distance of the spacers (see Figure 2.2.11.2.1.3.2) and
t_1 ..... mm..... is the thickness of the shuttering leaf.

The tensile load in the spacer P_t (p_{max}) shall be determined as follows:

$$P_t(p_{max}) = p_{max} h_b a$$

Where

p_{max}.....MPa ..... is the maximum concrete pressure according to to EN 15498*, Annex A,
h_b ..... mm..... is the height shuttering element (see Figure 2.2.12.2.1.3.2),
a ..... mm..... is the distance of the spacers (see Figure 2.2.12.2.1.3.2).

p_{max} according to EN 15498, Annex A depends on the thickness of the concrete core t_c (see EN 15498*, Figure A1) and has been determined under the following conditions:

- flow class F4 of the fresh concrete,
- filling height: 2,00 m and
- filling rate of 0,1 m/min.

For higher flow classes, filling heights or filling rates and missing measurement data for the pressure on the shuttering leaves the maximum concrete pressure p_{max} can also be determined, on the safe side, from the hydrostatic pressure $p_{max}=\rho_c*g*H$, where ρ_c is the density of the fresh concrete and H the filling height. In most cases g = 9.81 m/s².

Where

p_{max}..... Pa..... Hydrostatic concrete pressure
ρ_c.....kg/m³ ..... Density of fresh concrete
H.....m ..... Filling height
g.....m/s² ..... Gravitational acceleration

2.2.13 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 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.

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

2.2.14 Airborne sound insulation of the wall

The testing of walls for airborne sound insulation is performed under intended use conditions in accordance with EN ISO 10140-2*.

The measured airborne sound insulation is expressed as a single number rating, R_w, in accordance with EN ISO 717-1*.

2.2.15 Sound absorption

Testing of the sound absorption coefficient of materials is performed under intended use conditions as described in EN ISO 354*.

Mounting of specimens is according to the product configuration,

- EN ISO 354, Annex B, Type A mounting without air gap
- EN ISO 354, Annex B, Type B mounting with air gap

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*.

2.2.16 Thermal resistance of the wall

Thermal resistance 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 EN ISO 10456 and EN ISO 6946*.

Testing and determination of unknown thermal characteristics of kit components are conducted in accordance with EN 12667* or EN 12939*.

EN 1745* can also be used for masonry products.

The calculated or measured value of the thermal resistance (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.

If thermal insulation products according to a hEN are used within the kit, the declared values of thermal conductivity according the relevant standard shall be used for calculation.

In case of thermal bridges, the reference standard for calculation is EN ISO 10211 - Thermal bridges in building construction. Heat flows and surface temperatures. Detailed calculations

In the case of determination of thermal resistance by calculation, the calculation method and tools utilized (i.e software) are validated and calibrated beforehand by the TAB.

2.2.17 Thermal inertia

The following information is required to calculate the thermal inertia of the wall according to EN ISO 13786*:

• density of materials used (in kg/m^3) determined according to EN 1602*, Thermal insulating products for building applications – Determination of apparent density;

• total mass per unit area (in kg/m²) of the part of the wall which is internal face versus insulation sheet(s) based on the density and the thickness of the material;

• specific heat capacity of materials used (in J/kg K) – calculated according to EN ISO 13786*;

• thermal transmittance of materials used (in W/m² K) – calculated according to EN ISO 13786*.

• The detailed calculation according to EN ISO 13786 shall be applied.

This information shall be stated in the ETA.

2.2.18 Resistance to deterioration

Assessment of the resistance to deterioration applies mainly to the shuttering kits with incorporated finishes.

If not specified otherwise, chemical agents for testing are:

- oxalic acid, saturated aqueous solutions
- denaturated alcohol, > 95 % ethanol

For PVC shuttering elements:

- Testing of the surface durability against chemicals as in EN ISO 26987*.
- For the “internal” characteristics changing – testing acc.to EN ISO 175*: tensile testing (for the strength and elongation); variation of the volume – with pycnometer; variation of mass – by weighing. The characteristics shall be measured before and after storage in the testing liquid. The storage temp. shall be 40°C and test duration 16 weeks shall be implemented. Testing temperature shall be 23 °C ± 2 °C before and after storage.

The tensile test is performed according to EN ISO 527-2, specimen 1B, testing speed 5 mm/min

For each chemical agent

- The assessment according to table 1 of EN ISO 26987
- The arithmetic mean of change in tensile strength and elongation before and after immersion
- The arithmetic mean of change in volume before and after immersion
- The arithmetic mean of change in mass before and after immersion

shall be stated in the ETA.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

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

For the products covered by this EAD the applicable European legal act is Decision 98/279/EC as amended by Commission Decision 2001/596/EC of 8 January 2001.

The systems of assessment and verification of constancy of performance to be applied are as follows:

- System 2+ for all essential characteristics of the shuttering systems (except reaction to fire),
- In addition, with regards to reaction to fire for products covered by this EAD:
    - System 1 if the two following statements are valid:
    - intended use for the construction of external and internal walls subject to fire regulations, in buildings;

      and

    - reaction to fire classes A1, A2, B or C, for products/materials for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material).
    - System 2+ in other cases.

3.2 Tasks of the manufacturer

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

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [**including testing of samples taken at the factory in accordance with a prescribed test plan**]					
1	Incoming materials	Supplier data check	As defined in the control plan	As defined in the control plan	Each delivery
2	Dimensions of the shuttering elements	2.2.1	As defined in the control plan	As defined in the control plan	Every batch
3	Density of the shuttering material	2.2.17 EN 12390-7 EN ISO 1183-1	As defined in the control plan	As defined in the control plan	Every batch
4	Fire reaction of the material	2.2.4	As defined in the control plan	As defined in the control plan	Specified in the control plan
5	Web tensile strength and pull out load of spacer to leaf connection	2.2.12.2.1.2 2.2.12.2.1.3 EN 15498, Annex B	As defined in the control plan	As defined in the control plan	Specified in the control plan

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
6	Tensile strength perpendicular to the surface area of shuttering leaf	EN 1607	As defined in the control plan	As defined in the control plan	Specified in the control plan
7	Flexural strength of shuttering leaf	2.2.12.2.1.1 EN 15498, Annex C	As defined in the control plan	As defined in the control plan	Specified in the control plan
8	Strength of each concrete grade	EN 13369, D 3.1.8	As defined in the control plan	As defined in the control plan	Specified in the control plan
9	Thermal conductivity	EN 12667	As defined in the control plan	As defined in the control plan	Specified in the control plan
10	Visual check	By the personnel of the production to obvious defects	As defined in the control plan	As defined in the control plan	Specified in the control plan
	Further relevant subjects	To be added by the TAB	As defined in the control plan	As defined in the control plan	Specified in the control plan

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment of constancy of performance for the non load-bearing permanent shuttering kits/systems based on hollow blocks or panels of insulating materials and sometimes concrete are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	The notified body shall verify the ability of the manufacturer for a continuous and orderly manufacturing of the product. In particular, the following items shall be appropriately considered. – personnel and equipment – the suitability of the factory production control established by the manufacturer – full implementation of the prescribed test plan	By inspection	As defined in the control plan	As defined in the control plan	When starting the production, after starting a new production line or after modification of production processes
2	Where the intervention of the Notified Body is necessary because the conditions for the applicability of system 1 are fulfilled, the notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material).	By inspection	As defined in the control plan	As defined in the control plan	When starting the production, after starting a new production line or after modification of production processes

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Continuing surveillance, assessment and evaluation of factory production control					
3	The notified body shall verify that – the manufacturing process – the system of factory production control – the implementation of the prescribed test plan are maintained.	By inspection	As defined in the control plan	As defined in the control plan	Once per year
4	Where the intervention of the Notified Body is necessary because the conditions for the applicability of system 1 in the Decisions are fulfilled, the notified body will consider especially the clearly identifiable stage in the production process which results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material).	By inspection	As defined in the control plan	As defined in the control plan	Once per year

4 REFERENCE DOCUMENTS

EN 206 (2013) + A1 (2016)	Concrete — Specification, performance, production and conformity
EN 771-3 (2011)+A1 (2015)	Specification for masonry units — Part 3: Aggregate concrete masonry units (Dense and lightweight aggregates)
EN 772-11 (2011)	Methods of test for masonry units - Part 11: Determination of water absorption of aggregate concrete, autoclaved aerated concrete, manufactured stone and natural stone masonry units due to capillary action and the initial rate of water absorption of clay masonry units
EN 1363-1 (2012)	Fire resistance tests - Part 1: general requirements
EN 1363-2 (1999)	Fire resistance tests - Part 2: alternative and additional procedures
EN 1364-1 (2015)	Fire resistance tests for non-loadbearing elements - Part 1: walls
EN 1365-1 (2012) + AC (2013)	Fire resistance tests for loadbearing elements - Part 1: walls
EN 1602 (2013)	Thermal insulating products for building applications – Determination of apparent density
EN 1607 (2013)	Thermal insulating products for building applications — Determination of tensile strength perpendicular to faces
EN 1745 (2012)	Masonry and masonry products — Methods for determining thermal properties
EN 1990 (2002) +AC (2008) + AC (2010)	Eurocode - Basis of structural design
EN 1992-1-1 (2004) + AC (2008) + AC(2010) + A1 (2014)	Design of concrete structures Part 1-1: General rules and rules for buildings
EN 1992-1-2 (2004) + AC(2008) + A1 (2019)	Eurocode 2 : Design of concrete structures – Part 1 2 : General rules – Structural fire design
EN 12086 (2013)	Thermal insulating products for building applications - Determination of water vapour transmission properties
EN 12667 (2001)	Thermal performance of building materials and products – Determination of thermal resistance by means of guarded hot plate and heat flow meter methods – Products of high and medium thermal resistance
EN 12939 (2000)	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Thick products of high and medium thermal resistance
EN 13501-1 (2018)	Fire classification of construction products and building elements - Part 1 : classification using data from reaction to fire tests
EN 13501-2 (2016)	Fire classification of construction products and building elements — Part 1: Classification using data from reaction to fire tests, excluding ventilation services

EN 15435 (2008)	Precast concrete products - Normal weight and lightweight concrete shuttering blocks - Product properties and performance
EN 15498 (2008)	Precast concrete products - Wood-chip concrete shuttering blocks - Product properties and performance
EN ISO 62 (2008)	Plastics - Determination of water absorption (ISO 62:2008)
EN ISO 175 (2010)	Plastics - Methods of test for the determination of the effects of immersion in liquid chemicals
EN ISO 178 (2019)	Plastics - Determination of flexural properties
EN ISO 354 (2003)	Acoustics - Measurement of sound absorption in a reverberation room
EN ISO 527-2 (2012)	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:2012)
EN ISO 717-1 (2013)	Acoustics - Rating of sound insulation in buildings and of building elements - Part 1 : airborne sound insulation
EN ISO 6946 (2017)	Building components and building elements - Thermal resistance and thermal transmittance - Calculation methods
EN ISO 10211 (2017)	Thermal bridges in building construction - Heat flows and surface temperatures - Detailed calculations (ISO 10211:2017)
EN ISO 10140-2 (2010)	Acoustics - Laboratory measurement of sound insulation of building elements - Part 2 : measurement of airborne sound insulation
EN ISO 10456 (2007) + AC (2008)	Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values
EN ISO 11654 (1997)	Acoustics – Sound absorbers for use in buildings – Rating of sound absorption
EN ISO 12572 (2016)	Hygrothermal performance of building materials and products – Determination of water vapour transmission properties
EN ISO 13786 (2017)	Thermal performance of building components - Dynamic thermal characteristics - Calculation methods
EN ISO 16535 (2019)	Thermal insulating products for building applications - Determination of long term water absorption by immersion (ISO 16535: 2019)
EN ISO 26987 (2012)	Resilient floor coverings - Determination of staining and resistance to chemicals
CEN/TS 16637-2 (2014)	Construction products - Assessment of release of dangerous substances - Part 2: Horizontal dynamic surface leaching test
EAD 040083-00-0404 (2019)	External thermal insulation composite systems (ETICS) with renderings

ANNEX A – RESISTANCE TO FIRE MINIMUM DIMENSIONS OF CONCRETE INFILL

This annex is derived from EN 1992-1-2.

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 A.1 and A.2, in the general case of a wall exposed on one side.

The following preconditions have to be fulfilled.

- **Concrete**

  A normal weight concrete as defined in EN 206 or EN 1992-1-1 shall be used.

- **Strength of concrete**

  The strength of concrete shall be between C16/20 and C50/60 according to EN 206.

- **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 the shuttering elements for application of table A.1 in case of grid and column type**

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 intended use conditions by materials of class A1, A2, B or C, additionally the materials of spacers and shuttering leaves 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 A.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

- **Specifications for materials of shuttering for application of table A.2 (grid and column type)**

In the case where the specifications for applying table A.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 A.2:

Table A.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, shall not exceed 0,7. The slenderness of the concrete infill shall not exceed 50.

ANNEX B – DETERMINATION OF IMPACT RESISTANCE OF SHUTTERING ELEMENTS

B.1 Scope

This annex specifies test methods for impact resistance of shuttering elements.

B.2 Test method for determining soft body impact resistance

B.2.1 Principle

The soft body impact test simulates an impact resulting from a person accidentally falling against the wall.

The soft body is dropped from a height, creating an impact energy, which corresponds with the impact energy released by a person.

The test is conducted with reference to safety in use, i.e. verification whether the test specimen would prevent a person falling through, and to serviceability, i.e. verification whether they would still perform as intended.

B.2.2 Test apparatus

The large soft body impactor should be a spherical canvas bag of diameter 400 mm (± 40) (see Figure B.2.2.1) filled with 3.0 mm (± 0.3) diameter glass spheres to give a total weight of 50 kg (± 0.5).

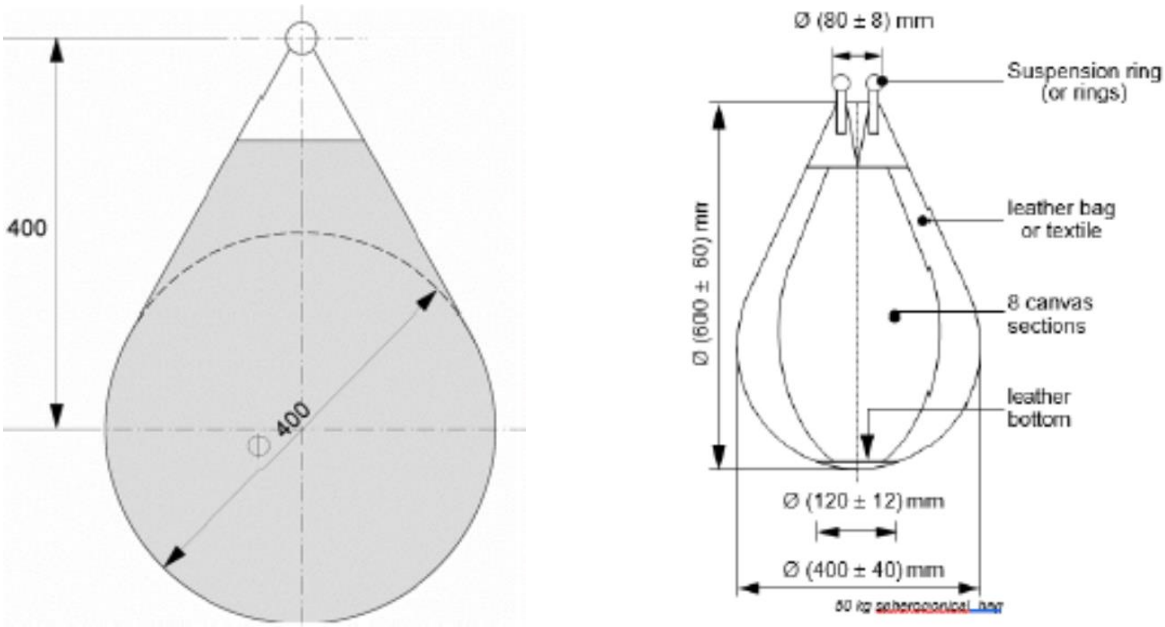

Figure B.2.2.1 – Large soft body impactor

The small soft body impactor should be a round ball with diameter 100 mm filled, with a mixture of sand and lead shot (grading 0-2 mm diameter) with an overall mass of 3 kg. The bag has an outer cover (1.5 mm thick) of flexible rubber reinforced with sail cloth or of an equivalent material.

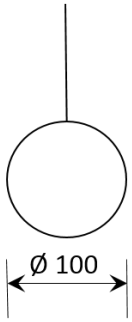

Figure B.2.2.2 – Small soft body impactor

B.2.3 Number of tests

B.2.3.1 Serviceability impact resistance

The test shall be carried out on one test specimen, and generally consists of at least three impacts with the same energy at about the same point of impact. The point of impact should be the one deemed most onerous for the test specimen under examination.

If various impact energies are being tested, new assemblies should be tested for each impact energy.

B.2.3.2 Safety in use impact resistance

The test shall be carried out on one test specimen and consists of one impact.

The point of impact should be the one deemed most onerous for the test specimen under examination.

If various impact energies are being tested, new test specimens should be tested for each level of impact energy.

Note - The serviceability and safety in use impact test should not be carried out on the same test specimen, unless the ETA-applicant of the test so wishes.

B.2.4 Conditioning and test conditions

The test wall conditioning shall be in line with manufacturer's instructions.

If not specified otherwise, test specimen with concrete infill and concrete specimens (cylinders, cubes) shall be cured and stored indoors for seven days. Thereafter, they may be stored outside, provided they are protected such that frost, rain, and direct sun does not cause a deterioration of the concrete compression and tension strength. When testing the concrete shall be at least 21 days old. The concrete strength shall be determined at the time of testing.

The test shall be carried out in normal laboratory circumstances.

B.2.5 Test specimen

The test walls shall be mounted in accordance with the manufacturer's installation specifications, with regard to the intended use, so that the test specimen corresponds as much as possible with intended use conditions.

The manner in which components are fixed to each other shall reproduce actual conditions of use, particularly with respect to the nature, type and position of the fixings and the distance between them.

If the manufacturer's specifications foresee more than one possible end-use assembly, the test shall be performed at least on the most onerous one.

The manufacturer has the possibility to test additional assemblies, if he claims better performance.

In principle, the most onerous test specimen shall be:

- shuttering leaves: the shuttering leaf with the highest ratio length (or height) over width in its minimum thickness;

- vertical distance: maximum distance between two floors.

B.2.6 Test procedure

In this test, the soft body impactor, with mass (m) is dropped from a height (h), so that the total impact energy

(E = g x h x m) corresponds with one of the following energies E in J: 60 (small soft body) and 400 (large soft body).

Note - In most cases g = 9,81 m/s^2.

The height (h) is measured between the designated point of impact and the height of release of the soft body impactor.

Where

E ..... J ..... Impact energy
h ..... m ..... Height
m ..... kg ..... Mass of impactor
g ..... m/s^2 ..... Gravitational acceleration

For tests conducted on wall assemblies the angle α shall always be smaller or equal to 65° (see Figure B.2.6.1).

The bag is held vertically when released (not horizontally).

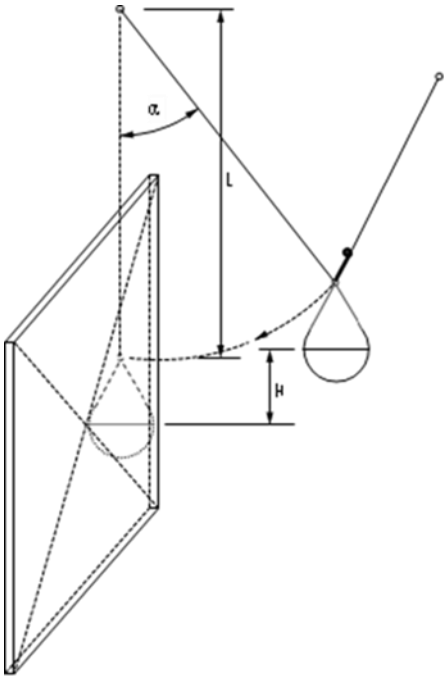

Figure B.2.6.1 – Impact on vertical test specimen h = drop height; L = length rope; a = 65°

The test can also be performed on a horizontal test specimen (see Figure B.2.6.2).

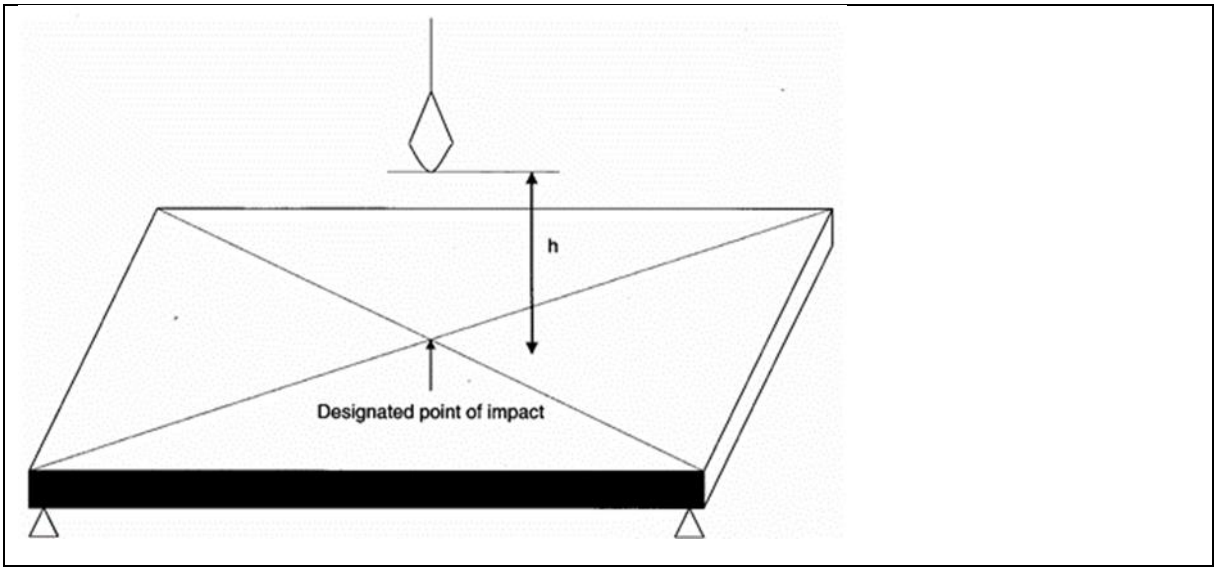

Figure B.2.6.2 – Vertical impact on horizontal test specimen h = drop height

B.2.7 Expression of test results

The following items shall be described:

For safety in use:

-collapse/no collapse: the test result is “no collapse” when, after the test, the test specimen maintains its mechanical integrity and is still capable of carrying its own weight in the tested position;

- penetration/no penetration: the test result is “no penetration” when, after the test, the impactor has not passed through the test specimen;

-projection/no projection: the test result is “no projection” when, after the test, the impactor has not created parts of the test specimen (e.g. core, face, reinforcement) to project from the face of the shuttering leaf, on the other side of the specimen than the impact side, creating sharp cutting edges or surfaces likely to cause personal injury by contact.

For serviceability:

-penetration/no penetration: the test result is “no penetration” when, after the test, the impactor has not penetrated the face of the test specimen on the impact side of the specimen.

-degradation/no degradation: the test result is “no degradation” when, after the test, there are no visible (to the unaided eye) cracks, depressions, protuberances or any other defects in the materials, which may influence the performance of the wall. Deformations, which only affect the appearance, are allowed, but should be mentioned in the test report.

The report shall indicate any damage (e.g. localized surface cavities of small dimensions, scratches, wear marks in the form of grooves, etc.).

For extended application of the test results, the general rule is that test results for the most onerous test specimen can be used to reflect the behaviour of others.

B.2.8 Test report

The test report shall include at least:

- reference to clause 2 of this annex;
- the name of the testing laboratory;
- the name of the ETA applicant (and manufacturer of the shuttering kit);
- date of the test;
- description of the test instruments;
- identification of the product tested (designation, dimensions and any relevant identification characteristic);
- surface structure (e.g. smooth, profiled, structured);
- description of the sample tested, and reference to its marking;
- description of conditioning and preparation of the sample (if any);
- description of test conditions (temperature and RH), where required;
- description of test procedure (height, energy level…)
- results of the test, including a description of safety (if any).

B.3 Test methods for determining hard body impact resistance

B.3.1 Principle

The hard body impact test simulates the impact, resulting from an object accidentally falling against the test specimen.

The hard body is dropped from a height, creating an impact energy, which corresponds with the impact energy released when furniture or similar objects are dropped.

The test is conducted with reference to safety in use, i.e. assessment whether the test specimen would prevent an object falling through, and to serviceability, i.e. verification whether they would still perform as intended (e.g. with reference to water vapour tightness).

B.3.2 Test apparatus

For safety in use, the hard body impactor should be a steel ball, with a diameter of 63.5 mm (± 1 mm), with a mass of 1030 g (± 40 g) (1 kg steel ball).

B.3.3 Number of tests

The test shall be carried out on one test specimen and consists of one impact.

The point of impact should be the one deemed most onerous for the test specimen under examination.

Note - The serviceability and safety in use impact test should not be carried out on the same test specimen, unless the ETA-applicant of the test so wishes.

B.3.4 Conditioning and test conditions

The test wall conditioning shall be in line with manufacturer's instructions.

If not specified otherwise, test specimen with concrete infill and concrete specimens (cylinders, cubes) shall be cured and stored indoors for seven days. Thereafter, they may be stored outside, provided they are protected such that frost, rain, and direct sun does not cause a deterioration of the concrete compression and tension strength. When testing the concrete shall be at least 21 days old. The concrete strength shall be determined at the time of testing.

The test shall be carried out in normal laboratory circumstances.

B.3.5 Test specimen

The test specimen shall be horizontally positioned on supports (see Figure B.3.5.1), to allow, in case of an unfavourable test result, the possibility of the impactor going completely through the test specimen.

The most onerous point of impact should be chosen.

In most cases this will be the centre of the test specimen with reinforcement (studs, stiffening ribs, etc.) behind a relatively weak face, the most onerous impact position is 25 mm (± 2) from the edge of the reinforcement.

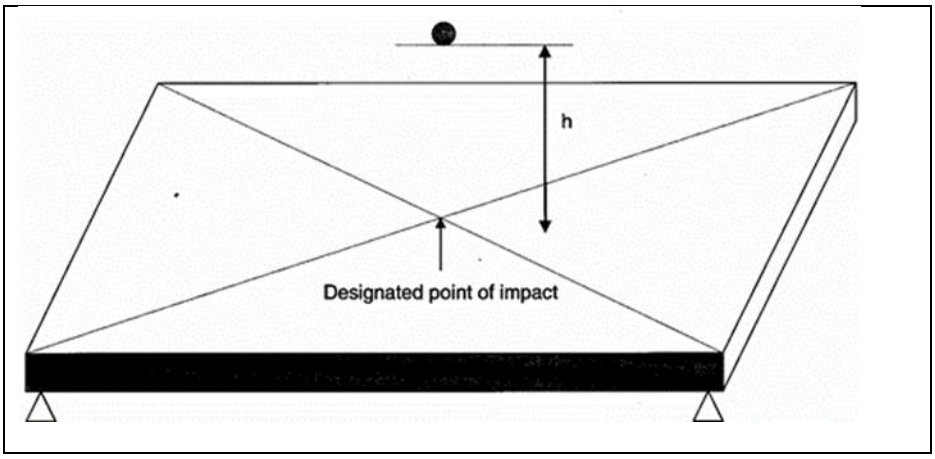

Figure B.3.5.1– Test specimen for hard body impact test

B.3.6 Test procedure

In this test, the hard body impactor with mass (m) is dropped from a height (h), so that the total impact energy (E = g x h x m) is 10 J (1 kg steel ball):

Note - In most cases g = 9,81 m/s2.

The height (h) is measured between the designated point of impact and the height of release of the hard body impactor.

Where

E ..... J ..... Impact energy
h ..... m ..... Height
m ..... kg ..... Mass of impactor
g ..... m/s^2 ..... Gravitational acceleration

B.3.7 Expression of test results

The following items shall be described:

Safety in use:

- collapse/no collapse: the test result is “no collapse” when, after the test, the test specimen maintains its mechanical integrity and is still capable of carrying its own weight in the tested position;

- penetration/no penetration: the test result is “no penetration” when, after the test, the impactor has not passed the test specimen;

- projection/no projection: the test result is “no projection” when, after the test, the impactor has not created parts of the panel (e.g. core, face, reinforcement) to project from the face of the panel, on the other side of the specimen than the impact side, creating sharp cutting edges or surfaces likely to cause injury by contact.

Serviceability:

- penetration/no penetration: the test result is “no penetration” when, after the test, the impactor has not penetrated the face of the test specimen on the impact side of the specimen;

- degradation/no degradation: the test result is “no degradation” when, after the test, there are no visible (to the unaided eye) cracks, depressions, protuberances or any other defects in the materials, which may influence the performance of the test specimen. Deformations, which only affect the appearance, are allowed, but should be mentioned in the test report.

The report shall indicate any damage (e.g. localized surface cavities of small dimensions, scratches, wear marks in the form of grooves, etc.).

For extended application of the test results, the general rule is that test results for the most onerous test specimen can be used to reflect the behaviour of others.

B.3.8 Test report

The test report shall include at least:

- reference to the clause 3 of this Annex;
- the name of the testing laboratory;
- the name of the ETA Applicant (and manufacturer of the panel);
- date of the test;
- description of the test instruments;
- identification of the product tested (designation, dimensions and any relevant identification characteristic);
- surface structure (e.g. smooth, profiled, structured,…);
- description of the sample tested, and reference to its marking;
- description of conditioning and preparation of the sample (if any);
- description of test conditions (temperature and RH), where required;
- description of test procedure (impactor, height, energy level…)
- results of the test, including a description of safety (if any).