EAD **332700-00-0601**

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August 2019

European Assessment Document for

Concrete screws for fastening sandwich panels

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 EAD

1.1 Description of the construction product

This EAD covers concrete screws for fastening sandwich panels to concrete structures (in the following referred to as “concrete screws”). The concrete screws are made of non-coated or inorganic coated galvanized steel or stainless steel and do not contain any organic components. The concrete screws can be complemented optional with sealing washers or metal washers or both. The effective size of the surface area of on side of the sealing washers is not higher than 25 cm².

The operation principle and installation of concrete screws are given in EAD 330232-01-0601. A figure and description of the screw connection is given in this EAD in Annex A.

The product is not covered by a harmonised European standard (hEN). The product is not fully covered by EAD 330232-01-0601, as attachment of sandwich panels is not included. By using the concrete screws with sandwich panels, the concrete screws are additionally subjected to bending (head deflection) due to thermal expansion of the sandwich panels. The assessment according to EAD 330232-01-0601 is based on tests carried out either for tensile or shear forces and does not cover tests under combined tensile and shear forces. Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

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

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

1.2 Information on the intended use of the construction product

1.2.1 Intended use

The concrete screws are intended to be used for fastening sandwich panels to concrete structures. The assessment according to this EAD is made to determine characteristic values of the mechanical fastener for essential characteristics needed as input parameters for design according to EN 1992-4[1].

The concrete screws for sandwich panels and the respective connections are intended to transfer wind and dead loads of sandwich panels into concrete structures. The screws are subject to shear forces (V) and longitudinal/axial forces (N) as well as to bending by a head displacement (u) due to temperature change of the sandwich panels.

Concrete screws covered by this EAD are intended to be used according to options 1 - 6 as specified in EAD 330232-01-0601 in uncracked and cracked concrete (Option 1 - 6).

The intended use comprises connections with predominantly static load (e.g., wind loads, dead loads).

The concrete screws are intended to be used in reinforced or unreinforced normal weight concrete without fibres with strength classes in the range C20/25 to C50/60 which are all in accordance with EN 206.

Concrete screws made of stainless steel are intended to be used in environmental conditions according to EN 1993-1-4, table A.1, dependent on the corrosion resistant class (CRC – depending on the material number, see EN 1993-1-4, table A.3). Concrete screws made of galvanized steel are intended to be used only in dry internal environment (category C1 according to EN ISO 12944-2, table 1).

The intended use takes into account, if any, a reduction of the pull-through resistance due to the position of the fastener according to EN 1993-1-3, clause 10.3 (7) and Table 10.1, for sandwich panels made of steel sheet, or EN 1999-1-4, Table 10.5, for sandwich panels made of aluminium sheet.

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

The concrete screws are not intended for re-use.

1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the concrete screws for fastening sandwich panels for the intended use of 50 years when installed in the works (provided that the concrete screws for fastening sandwich panels are subject to appropriate installation (see 1.1)). These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works[2].

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

1.3 Specific terms used in this EAD

1.3.1 Abbreviations

CS = concrete screw

C2 = corrosion resistance class according to the standard EN ISO 12944-2

SP1 = static pull-through test

SP2 = bending test and pull-out test

SP3 = cyclic pull-through test

SP4 = static shear test without gap

SP5 = static shear test with gap

1.3.2 Notations

d = panel thickness
F_{shear} = shear resistance of the fastener used for the tests
$F_{shear,\ min}$ = minimum shear resistance of the fastener
$F_{tension}$ = tension resistance of the fastener used for the tests
$F_{tension,min}$ = minimum tension resistance of the fastener according to the product standard
$F_{u,norm}$ = converted failure load for pull-through failure sandwich panel
$F_{u,Test}$ = failure load in a test
Gap = gap between anchorage ground and sandwich panel
$N_{max,test}$ = upper load for cyclic pull-through tests
$N_{min,test}$ = lower load for cyclic pull-through tests

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

$N_{Rk,SP}$	=	tension resistance
$N_{Rk,SP,cycl}$	=	cyclic tension resistance
R_m	=	tensile strength of the metal component t_{N1}/t_{N2} used for the tests
$R_{m,min}$	=	minimum tensile strength of the metal component t_{N1}/t_{N2} according to the product standard
t_{N1}	=	outer sheet thickness
$t_{N1,min}$	=	minimum thickness of the component t_{N1} according to the relevant product standard
t_{N2}	=	inner sheet thickness
$t_{N2,min}$	=	minimum thickness of the component t_{N2} according to the relevant product standard
u	=	head displacement due to temperature changes
$V_{Rk,SP}$	=	shear resistance
$V_{Rk,SP,Gap}$	=	shear resistance with gap
α	=	correction factor for load according to 2.2.1.4
α_{cycl}	=	reduction factor for cyclic pull-through according to 2.2.1.3

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 2.1.1 shows how the performance of concrete screws for fastening sandwich panels 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	Tension resistance of the connection between concrete screw and sandwich panel and associated head deflection	2.2.1	Level $N_{Rk,SP}$ [kN], $N_{Rk,SP,cycl}$ [kN] and u [mm]
2	Shear resistance of the connection between concrete screw and sandwich panel with and without a gap	2.2.2	Level $V_{Rk,SP}$ [kN], $V_{Rk,SP,Gap}$ [kN], Gap [mm] and u_{def} [mm]
3	Resistance to steel failure	EAD 330232-01-0601, 2.2.1	Level $N_{Rk,s}$ [kN]
4	Resistance to pull-out failure	EAD 330232-01-0601, 2.2.2	Level $N_{Rk,p}$ [kN], ψ_c [-]
5	Resistance to concrete cone failure	EAD 330232-01-0601, 2.2.3	Level $k_{cr,N}$, $k_{ucr,N}$ [-], h_{ef}, $c_{cr,N}$ [mm]
6	Robustness	EAD 330232-01-0601, 2.2.4	Level γ_{inst} [-]
7	Minimum edge distance and spacing	EAD 330232-01-0601, 2.2.5	Level c_{min}, s_{min}, h_{min} [mm]

No	Essential characteristic	Assessment method	Type of expression of product performance
8	Edge distance to prevent splitting under load	EAD 330232-01-0601, 2.2.6	Level $N^0_{Rk,sp}$ [kN], $c_{cr,sp}$ [mm]
9	Resistance to steel failure under shear load	EAD 330232-01-0601, 2.2.7	Level $V^0_{Rk,s}$ [kN], $M^0_{Rk,s}$ [Nm], k_7 [-]
10	Resistance under pry-out failure	EAD 330232-01-0601, 2.2.8	Level k_8 [-]
Basic Works Requirement 2: Safety in case of fire			
11	Reaction to fire	2.2.3	Class
Aspects of durability			
12	Resistance to neutral salt spray for an exposure period in hours	2.2.4.1	level [h]
13	Resistance to humid atmospheres containing sulphur dioxide for an exposure period in hours (30 cycles)	2.2.4.2	level [h]
14	Natural weathering for an exposure period	2.2.4.3	level [years / month / weeks]
15	Durability of the screw in concrete	2.2.4.4	Description

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

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

Any manufacturer’s installation instructions (e.g., drilling technology, hole cleaning, installation tools, torque moments) shall be respected when preparing test specimens, as relevant, and stated in the ETA.

2.2.1 Tension resistance of the connection between concrete screw and sandwich panel and associated head deflection

2.2.1.1 Resistance to static pull-through failure at the sandwich panel (SP1)

The load-bearing capacity of the concrete screw is associated to the bending capacity (head deflection) and shall be assessed and additionally given in accordance with clause 2.2.1.2.

Purpose of the test

The purpose of the test is to determine the static characteristic resistance of the connection between the sandwich panel and the concrete screw in case of tensile loading of the sandwich panel.

Test conditions

The test setup is shown in Annex B, see B.2.

All sizes and head forms shall be tested.

At least 10 pull-through-tests shall be carried out for each relevant sheeting thickness t_{N1}. The test load shall be increased until pull-through of the fastener or failure of fastener occurs. If a failure other than described occurs the test results shall not be used (see Annex A).

The displacement-controlled loading rate shall not exceed 5,0 mm/min and shall not fall below 1,0 mm/min.

2.2.1.2 **Expression of results**The pull-through resistance $N_{Rk,SP}$ [kN] of the fastening concrete screw is the failure load of the static pull-through test taking into account the reduction coefficient and statistical evaluation given in clause 2.2.1.3 and shall be stated in the ETA.Bending capacity (head deflection) for thermal expansion of the outer sheet of sandwich panel (SP2)

Purpose of the test

To assess the bending capacity of the fastening concrete screws (for thermal expansion of the outer sheet of the sandwich panel) bending tests shall be carried out.

The tests shall be done in addition to the tests in clause 2.2.1.1.

Test conditions

An example for the test setups is shown in Annex B, see B.3 (Figures B.3.2 and B.3.3).

The cantilever length of the concrete screw shall correspond to the thickness of the sandwich panel.

All sizes, head forms and cantilever length shall be tested.

For the test the concrete screw shall be installed into a test specimen with a concrete substructure. In order to prove that a concrete failure is excluded for the given application the concrete substructure shall have the lowest intended strength properties and dimensions:

- minimum embedment depth of the concrete screw,
- minimum edge distances,

- concrete without reinforcement,
- lowest concrete strength, (over strength shall be excluded).

The bending capacity shall be tested by at least 10 bending tests for each relevant sandwich panel thickness.

The upper end of the concrete screw shall be displaced with a maximum frequency of 5,0 Hz (and shall not fall below 1,0 Hz) in the following manner:

100 times with u,

2000 times with 0.86 u, and

20000 times with 0.57 u,

with u = maximum displacement of the upper end of the concrete screw.

The displacement u depends on the service conditions of the application and is defined by the manufacturer. If no value is given by the manufacturer, the default value is u = 20,0 mm (Tolerance ∓ 0,1 mm). In case of insufficient test results, either the head deflection or the tensile resistance of the concrete screw shall be reduced and the tests shall be repeated.

Expression of Results

Each concrete screw that is tested shall pass the 22100 bending cycles with the given loading regimes.

The pull-out residual resistance of the fastening concrete screw after the bending test shall be compared with the reference value evaluated according to “Pull-out test”. The comparison shall be done using mean values. If the pull-out residual resistance is less than 80 %, the head deflection u shall be reduced until the 80 % remaining capacity is safely reached in the tests.

The detected and verified head deflection u [mm] and the corresponding load capacities of the concrete screws $N_{Rk,SP,cycl}$ [kN] taking into account the reduction coefficient and statistical evaluation given in clause 2.2.1.3 and shall be stated in the ETA.

2.2.1.3 Determination of characteristic values of tension resistance of the connection between concrete screw and sandwich panel

The decisive minimum values of the test results according to 2.2.1.1 and 2.2.1.2 (failure loads or maximum loads) shall be multiplied by the following correction factors α which depends on the failure mode:

Test according to static or cyclic pull-through tests:

- Pull-through failure: $\alpha = (R_{m,min}/R_m) \cdot (t_{N1,min}/t_{N1}) \leq 1,0$
- Failure of fastener: $\alpha = F_{tension,min} / F_{tension} \leq 1,0$

With:

$R_{m,min}$ = minimum tensile strength of the metal component t_{N1} according to the product standard

R_m = tensile strength of the metal component t_{N1} used for the tests

$F_{tension,min}$ = minimum tension resistance of the fastener according to the product standard

$F_{tension}$ = tension resistance of the fasteners used for the tests

$t_{N1,min}$ = minimum thickness of the component t_{N1} according to the relevant product standard

t_{N1} = thickness of the relevant component t_{N1} used for the tests.

The corrected test results shall be evaluated statistically (determination of 5% fractile using a confidence level of 75%). Generally, a normal distribution can be assumed.

The corrected and statistically evaluated test results (5% fractile) of the tests according to "Static pull-through tests" shall be used as the characteristic values of the static pull-through resistance of the connection.

The cyclic tension resistance $N_{Rk,SP,cycl}$ shall be calculated by the static pull-through resistance $N_{Rk,SP}$ multiplied by the reduction factor α_{cycl} : = 2/3 = 0.67 that takes into account the influence of repeated wind loads[3] .

$N_{Rk,SP,cycl} = N_{Rk,SP} \cdot 0.67.$

2.2.2 Shear resistance of the connection between concrete screw and sandwich panel with and without a gap

2.2.2.1 Static shear tests without gap (SP3)

Purpose of the test

The purpose of the test is to determine the static characteristic resistance $V_{Rk,SP}$ of the connection between the sandwich panel and the concrete screw in case of static shear loading of the concrete screw anchors.

Test conditions

The test setup is shown in Annex B, see B.4.

All sizes and head forms shall be tested.

At least 10 shear tests shall be carried out for each relevant combination of inner sheet thickness t_{N2}.

The test load shall be increased until shear failure of the fastening concrete screw or local bearing deformation (hole elongation) of the sheeting occurs. The maximum load which shall be taken into account to determine the relevant characteristic resistance is the maximum load which corresponds to a deformation capacity of u_{def} = 3,0 mm (Tolerance $\mp$ 0,1 mm) as common default value. On request of the manufacturer other values for u_{def} can be used. The displacement-controlled loading rate shall not exceed 1,0 mm/min and shall not fall below 0,1 mm/min.

If any failure occurs within the deformation capacity u_{def}, the test results cannot be used. In this case, according to Annex A either the concrete strength can be increased or the screwing depth can be increased or both, or the deformation capacity u_{def} can be reduced. Once the deformation capacity has been reached, failure has no effect on the test results. The test conditions shall be given in the ETA.

Expression of results Failure of the inner metal sheet: $\alpha = (R_{m,min}/R_m) \cdot (t_{N2,min}/t_{N2}) \leq 1{,}0$

Shear failure of fastener: $\alpha = F_{shear,min} / F_{shear} \leq 1{,}0$

With:

$R_{m,min}$ = minimum tensile strength of the inner metal sheet t_{N2} according to the material standard

R_m = tensile strength of the inner metal sheet t_{N2} used for the tests

$F_{shear,min}$ = minimum shear resistance of the fastener

F_{shear} = shear resistance of the fastener used for the tests

$t_{N2,min}$ = minimum thickness of the inner metal sheet t_{N2} according to the product standard

t_{N2} = thickness of the inner metal sheet t_{N2} used for the tests

The corrected and evaluated test results shall be evaluated statistically (determination of 5% fractile using a confidence level of 75%). Generally, a normal distribution can be assumed. $V_{Rk,SP}$ [kN] and u_{def} shall be stated in the ETA.

3 Background information is given in the ECCS-Document №124 – ISBN No. 92-9147-000-91

2.2.2.2 Static shear tests with gap (SP4)

Purpose of the test

The purpose of the test is to determine the static characteristic resistance $V_{Rk,SP}$ of the connection between the sandwich panel and the concrete screw in case of static shear loading with a gap. The default gap to be tested is 20 mm (Tolerance $\mp$ 0,1 mm). The manufacturer may request further distances to be assessed additionally.

Test conditions

The test setup is shown in Annex B, see B.5.

At least 10 shear tests shall be carried out for each relevant combination of sheet thickness t_{N2}.

The gap between the sandwich panel and the substructure made of concrete shall be simulated using, e.g., PTFE (polytetrafluorchlorethylene) layers with a thickness of the gap. All specified gap distances shall be tested.

The test load shall be increased until shear failure of the fastening concrete screw or local bearing deformation (hole elongation) of a sheeting or the substructure occurs. The maximum load which shall be taken into account to determine the relevant characteristic resistance is assumed to be the maximum load which corresponds to a deformation capacity of u_{def} = 3,0 mm as common default value. On request of the manufacturer other values for u_{def} can be used. The displacement-controlled loading rate shall not exceed 1,0 mm/min and shall not fall below 0,1 mm/min.

Expression of Results

Failure of the inner metal sheet: $\alpha = (R_{m,min}/R_m) \cdot (t_{N2,min}/t_{N2}) \leq 1,0$

Shear failure of fastener: $\alpha = F_{shear,min} / F_{shear} \leq 1,0$

With:

$R_{m,min}$ = minimum tensile strength of the inner metal sheet t_{N2} according to the product standard

R_m = tensile strength of the inner metal sheet t_{N2} used for the tests

$F_{shear,min}$ = minimum shear resistance of the fastener

F_{shear} = shear resistance of the fastener used for the tests

$t_{N2,min}$ = minimum thickness of the inner metal sheet t_{N2} according to the product standard

t_{N2} = thickness of the inner metal sheet t_{N2} used for the tests.

The corrected and evaluated test results shall be evaluated statistically (determination of 5% fractile using a confidence level of 75%). Generally, a normal distribution can be assumed. $V_{Rk,SP,Gap,}$ [kN], Gap [mm] and u_{def} shall be stated in the ETA.

2.2.3 Reaction to fire

The concrete screws and optional metal washers in the scope of this EAD as defined in clause 1.1 for fastening sandwich panels are considered to satisfy the requirements of class A1 of the reaction-to-fire performance in accordance with the Commission Decision 96/603/EC[4], as amended by Commission Decisions 2000/605/EC[5] and 2003/424/EC[6], without the need for testing on the basis of it fulfilling the conditions set out in that Decision and its intended use being covered by that Decision.

4 Official Journal of the European Communities № L 267, 19.10.1996

5 Official Journal of the European Communities № L 258, 12.10.2000

6 Official Journal of the European Communities № L 144, 12.06.2003

Therefore, the performance of the concrete screws for fastening sandwich panels is class A1 and shall be stated in ETA.

Considering the provisions in clause 1.1 for the optional sealing washers (for example made of plastics or rubber), they fulfil the following requirements:

- Effective size of the surface area of one side of the washer ≤ 25 cm² (calculated taking into account the outer diameter minus the diameter of the hole for the screws)
- Effective weight ≤ 50 g

Therefore, the sealing washers can be considered as a small component and its reaction to fire performance can be neglected and doesn't need to be tested and classified separately. This information shall be stated in the ETA, since the contribution of these washer to fire is negligible.

2.2.4 Durability

2.2.4.1 Resistance to neutral salt spray for an exposure period in hours

Purpose of the test

The purpose of the test is to determine an exposure period in hours under neutral salt spray conditions

Test conditions

The test is conducted in accordance with EN ISO 9227 (neutral salt spray - NSS) for an exposure period in hours.

Test samples shall be representative for the intended assembly simulating connection. Therefore, the test panels shall be made from the same type of metals and possibly coated as intended to be used in practice. The panel size is 150 x 100 mm (Tolerance ∓ 1 mm). Both the sheet metals used as test panels and the fastener shall be tested in condition as supplied.

At least 10 equal specimens shall be tested for each relevant configuration of fastener and sheet metals concerning their corrosion protection systems. They shall be arranged together in one testing cabinet.

All concrete screw diameters and coatings which are intended to be covered by the ETA shall be assessed.

Expression of results

After an exposure period (Recommendations for duration of exposure are 2 h, 6 h, 24 h, 48 h, 96 h, 168 h, 240 h, 480 h, 720 h and 1000 h; the manufacturer may ask in addition for other durations) the corrosion on the metal surface of the specimen shall be described and assessed according to EN ISO 12944-6, clause 6.3.

If the conditions for passing EN ISO 12944-6, clause 6.3, are no longer fulfilled, the last period duration during which this was still the case shall be indicated.

2.2.4.2 Resistance to humid atmospheres containing sulphur dioxide for an exposure period in hours (30 cycles)

Purpose of the test

The purpose of the test is to determine an exposure period in hours under humid atmospheres containing sulphur dioxide conditions.**Test method**

The test is conducted in accordance with EN ISO 3231 (gas volume: one liter) for an exposure period in hours (30 cycles).

Test samples shall be representative for the intended assembly connection. Therefore, the test panels shall be made from the same type of metals and possibly coated as intended to be used in practice. The panel size shall be 150 x 100 mm (Tolerance ∓ 0,1 mm). Both the sheet metals used as test panels and the fastener shall be tested in condition as supplied.

At least 10 equal specimens shall be tested for each relevant configuration of fastener and sheet metals concerning their corrosion protection systems. They shall be arranged together in one testing cabinet.

All relevant concrete screw diameters and coatings shall be assessed.

Expression of results

After an exposure period (Recommendations for duration of exposure are 2 h, 6 h, 24 h, 48 h, 96 h, 168 h, 240 h, 480 h, 720 h and 1000 h; the manufacturer may ask in addition for other durations) the condition of the concrete screw shall be assessed with regard to blistering, cracks, peeling, rust (staining) in accordance with EN ISO 12944-6, clause 6.3, and dislocation of the tapes.

If the conditions for passing EN ISO 12944-6, clause 6.3, are no longer fulfilled, the last period duration during which this was still the case shall be indicated.

2.2.4.3 Natural weathering for an exposure period

Purpose of the test

The purpose of the test is to determine an exposure period under natural weathering conditions.

Test method

The test shall be conducted in accordance with EN ISO 2810 for an exposure period in years.

In particular, the following parameters shall be considered:

The location of the exposure site where the concrete screw is intended to be used, for example industrial, marine, rural. In choosing sites, those which differ markedly in the type or level of pollution from the normal shall be avoided, unless they are appropriate to the intended end use of the coating under test.

Expression of results

At the end and also during the exposure period, the conditions specified in EN ISO 2810 shall be observed.

At the end of the exposure period the condition of the concrete screw shall be assessed with regard to blistering, cracks, peeling, rust (staining). The elapsed time in which none of the above-mentioned symptoms occur (years, months, weeks) and location of the exposure site shall be given in the ETA.

2.2.4.4 Durability of the screw in concrete

To assess the durability of the screw in concrete EAD 330232-01-0601, clause 2.2.20 a), applies.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is Commission Decision 96/582/EC.

The system to be applied is **1**.

3.2 Tasks of the manufacturer

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

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of 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	material parameters	inspection documents 3.1 according to EN 10204	Laid down in control plan	-	Every manufacturing batch
2	Dimensions (outer diameter, thread length, etc.)	Calliper and/or gauge	Laid down in control plan	3	Every manufacturing batch or 100.000 elements or when raw material batch has been changed**)
3	Tensile Load or tensile strength *)	EN ISO 6892-1 EN ISO 898-1 EN ISO 3506-1	Laid down in control plan	3	Every manufacturing batch or 100.000 elements or when raw material batch has been changed**)
4	Yield strength *)	EN ISO 6892-1 EN ISO 898-1 EN ISO 3506-1	Laid down in control plan	3	Every manufacturing batch or 100.000 elements or when raw material batch has been changed**)
5	Core hardness and Surface hardness (at specified functioning relevant points of the product) – where relevant	Tests according to EN ISO 6507 parts 1 to 4 or EN ISO 6508 parts 1 to 3	Laid down in control plan	3	Every manufacturing batch or 100.000 elements or when raw material batch has been changed**)
6	Zinc plating - where relevant	x-ray measurement according to EN ISO 3497, magnetic method according to EN ISO 2178 Phase-sensitive eddy-current method according to EN ISO 21968	Laid down in control plan	3	Every manufacturing batch or 100.000 elements or when raw material batch has been changed**)
7	Fracture elongation - where relevant	EN ISO 6892-1 EN ISO 898-1	Laid down in control plan	3	Every manufacturing batch or 100.000 elements or when raw material batch has been changed**)
8	Hard metal tip of fastener made of stainless steel - where relevant.	Check of material, geometry, position and fixing to stainless steel	Laid down in control plan	3	Every manufacturing batch or 100.000 elements or when raw material batch has been changed**)

*) Tests according to this standard, however, are, if necessary, performed on the finished product with the corresponding adaptations agreed between manufacturer and TAB (e.g., geometrical aspects).

**) The lower control interval is decisive.

3.3 Tasks of the notified body

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

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	Ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the mechanical fastener	Verification of the complete FPC, to be implemented by the manufacturer	Laid down in control plan	-	When starting the production or a new line
Initial inspection of the manufacturing plant and of factory production control					
2	Verifying that the system of factory production control and the specified automated manufacturing process are maintained taking account of the control plan	Verification of the controls carried out by the manufacturer on the raw materials, on the process and on the product as indicated in Table 3.2.1	Laid down in control plan	-	1/year

4 REFERENCE DOCUMENTS

EN 206:2013+A2:2021	Concrete – Specification, performance, production and conformity
EN 1992-4: 2018	Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for use in concrete
EN 1993-1-3:2024	Eurocode 3 - Design of steel structures - Part 1-3: Cold-formed members and sheeting
EN 1993-1-4:2006/A2:2020	Eurocode 3: Design of steel structures – Part 1-4: General rules – Supplementary rules for stainless steels
EN 1999-1-4:2023	Eurocode 9 - Design of aluminium structures – Part 1-4: Cold-formed structural sheeting
EN 10204:2004	Metallic products - Types of inspection documents
EN 10346:2015	Continuously hot-dip coated steel flat products for cold forming - Technical delivery conditions
EN ISO 898-1:2013+AC:2013	Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs with specified property classes – Coarse thread and fine pitch thread (ISO 898-1:2013+Cor1:2013)
EN ISO 2178:2016	Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method (ISO 2178:2016)
EN ISO 2810:2020	Paints and varnishes - Natural weathering of coatings - Exposure and assessment (ISO 2810:2020)
EN ISO 3231:1997	Paints and varnishes - Determination of resistance to humid atmospheres containing sulfur dioxide (ISO 3231:1993)
EN ISO 3497:2000	Metallic coatings – Measurement of coating thickness – X-ray spectrometric methods (ISO 3497:2000)
EN ISO 3506-1:2020	Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners – Part 1: Bolts, screws and studs with specified grades and property classes (ISO 3506-1:2020)
EN ISO 6507 Parts 1 to 4	Metallic materials – Vickers hardness test – Part 1: Test method (EN ISO 6507-1:2023); Part 2: Verification and calibration of testing machines (EN ISO 6507-2:2018); Part 3: Calibration of reference blocks (EN ISO 6507-3:2018); Part 4: Tables of hardness values (EN ISO 6507-4:2018)
EN ISO 6508 Parts 1 to 3	Metallic materials - Rockwell hardness test - Part 1: Test method (EN ISO 6508-1:2023); Part 2: Verification and calibration of testing machines and indenters (EN ISO 6508-2:2023); Part 3: Calibration of reference blocks (EN ISO 6508-3:2023)
EN ISO 6892-1:2019	Metallic materials – Tensile testing – Part 1: Method of test at room temperature (ISO 6892-1:2019)
EN ISO 9227:2022	Corrosion tests in artificial atmospheres – Salt spray tests (ISO 9227:2022)
EN ISO 12944-2:2017	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 2: Classification of environments (ISO 12944-2:2017)
EN ISO 12944-6:2018	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 6: Laboratory performance test methods (ISO 12944-6:2018)

EN ISO 21968:2019	Non-magnetic metallic coatings on metallic and non-metallic basis materials - Measurement of coating thickness - Phase-sensitive eddy-current method (ISO 21968:2019)
EAD 330232-01-0601	Mechanical fasteners use for concrete
ECCS №124, 2nd edition, 2009	The Testing of Connections with Mechanical Fasteners in Steel Sheeting and Sections - ISBN No. 92-9147-000-91

ANNEX A: DETAILED DESCRIPTION OF THE CONCRETE SCREW CONNECTION AND USE

The screws shall be tested on test specimens with sandwich panels, see Figure A.1, which consist of 2 metal sheets (an outer sheet with a thickness of t_{N1} and an inner one with a thickness of t_{N2}) and a core made of insulating material.

A common default structure of sandwich panel is t_{N1}=0,75 mm, t_{N2} = 0,75 mm, S280GD according to EN 10346, with a core made of rigid polyurethane foam. The thicknesses of sandwich panels d to be tested are at least the smallest thickness and the largest thickness. Other sandwich panel structures can also be tested on request of the manufacturer.

Intermediate values of d cannot be interpolated due to possibly different failure mechanisms (such as perforation, screw bending) and may also be tested at the manufacturer's request.

Test results may be used without testing for sandwich panels that have thicker sheet thicknesses t_{N1} or t_{N2} or both with an otherwise identical structure and thickness. Nevertheless, the screws may also be tested and assessed for sandwich panel structures with thicker sheet thicknesses.

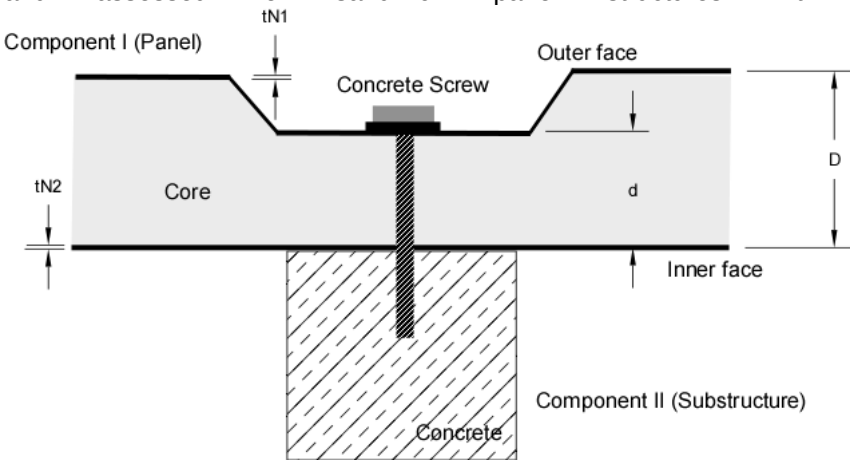


Figure A.1: Example of an application of concrete screws used to fix sandwich panels at a substructure made of concrete.

The thickness of the sandwich panel is d in the part where the concrete screw is fixed to the substructure and the maximum thickness of the sandwich panel is given with D.

The concrete screw is anchored in the concrete. Common default values of the concrete strength is C20/25 and a screw depth that is 5 times the screw diameter. Other values can be used at request of the manufacturer. In the event of concrete failure (screw breaking out or concrete spalling) test results cannot be used, the concrete strength class or screw depth or both shall then be increased and the tests repeated. The ETA shall indicate for which concrete strength and screw-in depth the performance was assessed.

Standard information for making the drill hole and connection if no installation instructions are available from the manufacturer:

- The drilling shall be carried out vertically on substrate on horizontal position (as on the construction site) and shall at least be 10 mm deeper than the screw-in depth of the screw.
- There is no special drill hole cleaning (such as blowing out or brushing out or both).
- Screws are driven vertically to the substrate in horizontal position.
- No special torque is required; the screw connection shall be carried out in such a way that the sandwich panel is pressed hand-tight or in case of tests without sandwich panel the overhang length corresponds to the thickness d.

At the manufacturer's request, a different installation can be carried out according to the manufacturer's product installation instructions.

ANNEX B: TEST PROGRAMME AND TEST SETUPS

B.1 - Summary of the test programme

In the following table the test programme is summarized. The tests are described in detail in clause 2.2.

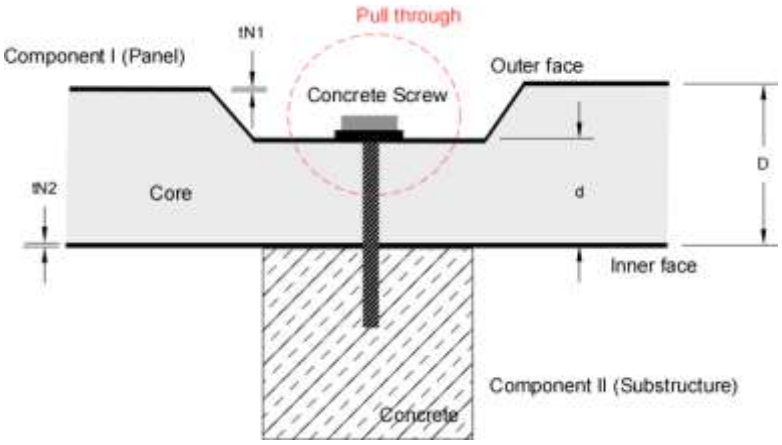
Table B.1: Summary of the test programme for concrete screws used for fastening sandwich panels.

No.	Purpose of test	Size	Number of cycles	t_{N1}	t_{N2}	Head form	n_{min}	Result	clause
SP1	Static pull-through	All	-	min.	min.	All	10	$N_{Rk,SP}$	2.2.1.1
SP2	Bending Test and pull-out test[7]	All	22100	min.	min.	All	10	($\alpha \geq 0.8$) u	2.2.1.2
SP3	Static shear test without gap	All	-	min.	min.	All	10	$V_{Rk,SP}$	2.2.2.1
SP4	Static shear test with gap[8]	unfavourable	-	min.	min.	All	10	$V_{Rk,SP,Gap}$	2.2.2.2
CS	Characteristic resistance of the concrete screw	All	-	-	-	Test programme for concrete screw according to EAD 330232-01-0601			2.2.5

7 There are sufficient pull-out values to be determined as reference values before cyclic loading.

8 The maximum distance of the gap is defined by the manufacturer. If the capacity for more than one gap distance is applied for all gap distances shall be tested. The resistance assessed for largest gap distances can be also taken for the smaller ones.

B.2 - Test setup for static pull-through tests (SP1)



Note: The Figure B.2.1 shows the area of potential failure (red), which is in focus when test is performed; it does not show the test setup, but the installed state.

Figure B.2.1: Principle illustration of the tested failure mechanism (red), shown in installed condition

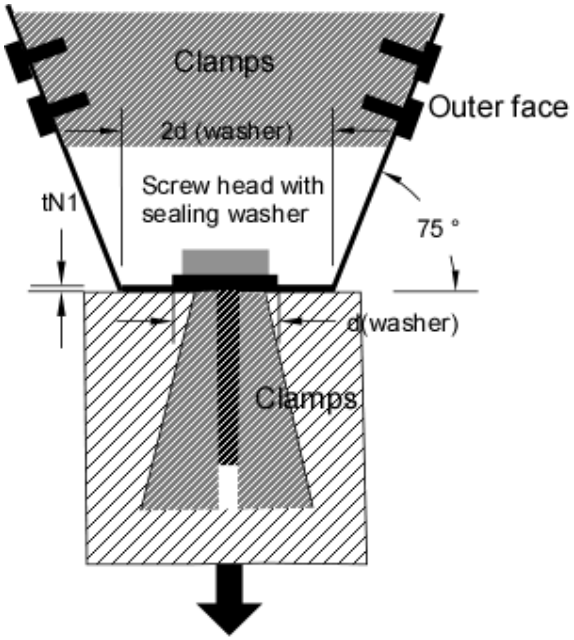
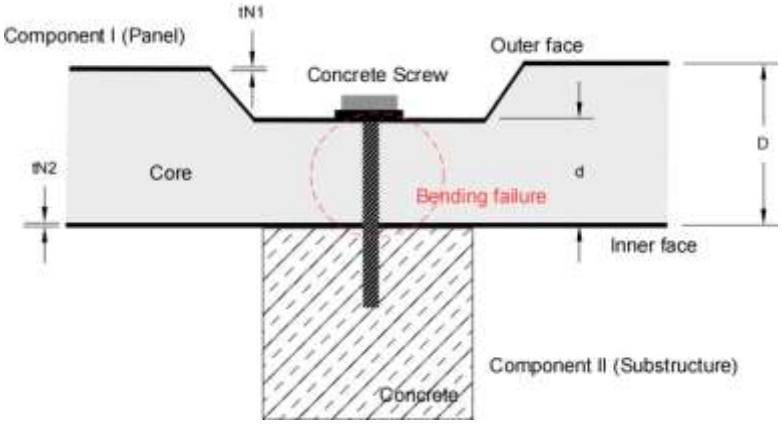


Figure B.2.2: Test setup for static pull-through tests of the concrete screw head through the outer face (sheet).

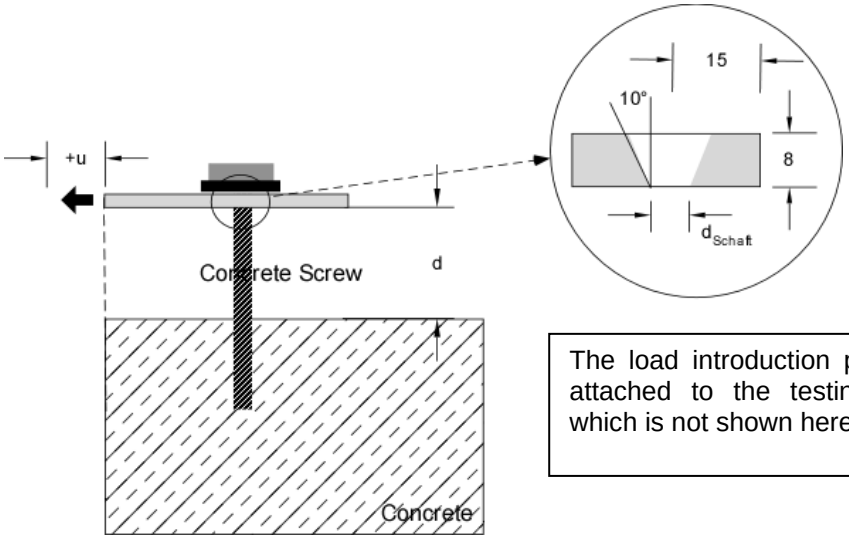
B.3 - Test setup for bending tests (SP2)



Note: The Figure B.3.1 shows the potential area of interest with respect to bending failure (red) when the test is performed; it does not show a test setup, but the installed state.

Figure B.3.1: Principle illustration of the tested failure mechanism (red), shown in installed condition

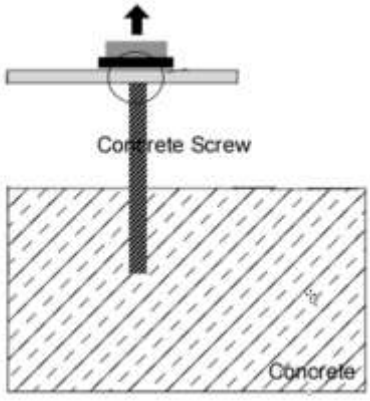
Test of cyclic lateral head deflection



The load introduction plate is only attached to the testing machine, which is not shown here.

Figure B.3.2: Test setup for the bending tests (connection capacity reduction factor due to bending).

Pull-out test before and after cyclic lateral head deflection stress

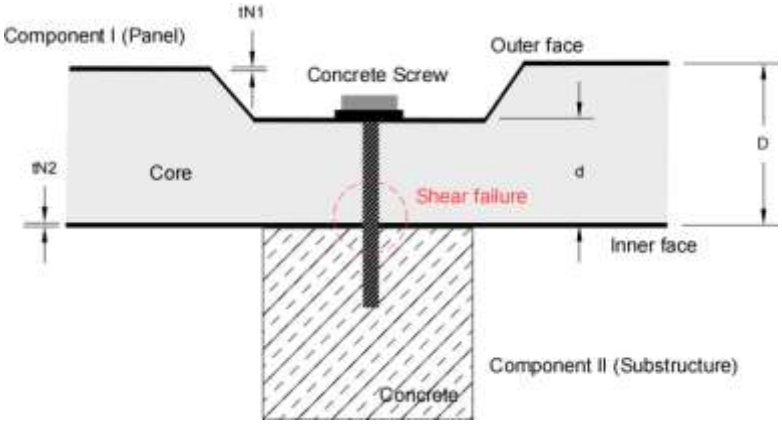


Other boundary conditions of the test correspond to the Figure B.3.2.

Any influence from the load introduction plate of the horizontal load introduction shall be ruled out.

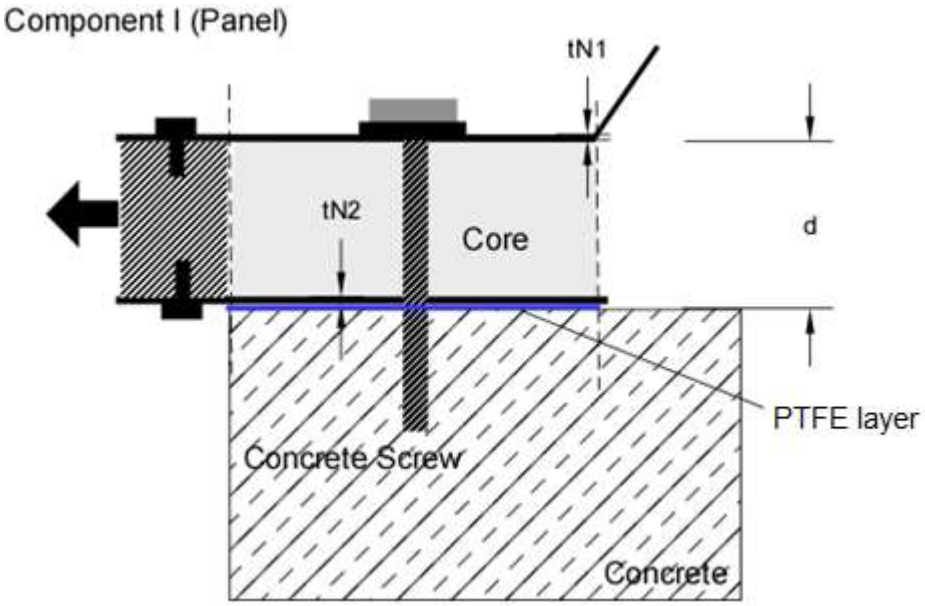
Figure B.3.3: Pull out tests of the concrete screw out of the concrete in the course of bending tests, before and after cyclic lateral head deflection.

B.4 - Test setup for shear tests without gap (SP3)



Note: The Figure B.4.1 shows the potential area of interest with respect to shear failure (red) when the test is performed; it does not show a test setup, but the installed state.

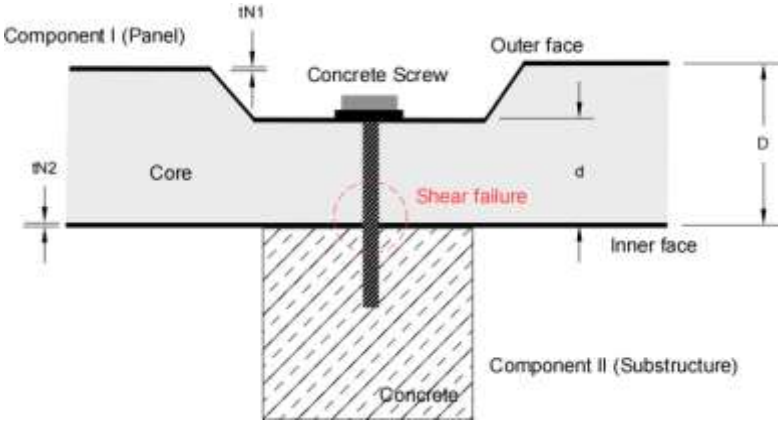
Figure B.4.1: Principle illustration of the tested failure mechanism (red), shown in installed condition



Displacement transducer (between the concrete and the load application point on the sandwich panel) measure the deformation to determine u_{def}.

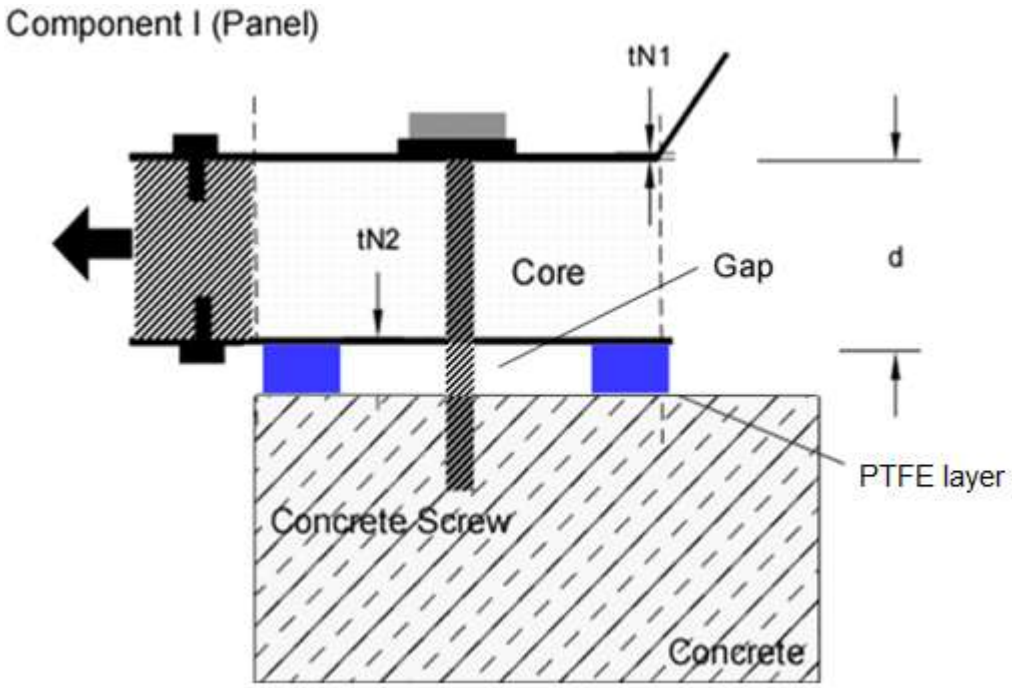
Figure B.4.2: Test setup for the shear tests (connection capacity).

B.5 - Test setup for shear tests with gap (SP4)



Note: The Figure B.5.1 shows the potential area of interest with respect to shear failure (red) when the test is performed; it does not show a test setup, but the installed state.

Figure B.5.1: Principle illustration of the tested failure mechanism (red), shown in installed condition



Displacement transducer (between the concrete and the load application point on the sandwich panel) measure the deformation to determine u_{def}.

Figure B.5.2: Test setup for the shear tests (connection capacity with gap).