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EAD **332347-00-0601-v01**

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European Assessment Document for

Connector for strengthening of existing concrete structures by concrete overlay: behaviour under seismic action

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).

Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

EAD 332347-00-0601[1] [1], applies.

This EAD is a variant to EAD 332347-00-0601 [1], to take into account the behaviour of the connector under seismic actions.

Therefore, new assessments/essential characteristics are added (see Table 2.1.1).

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

1.2.1 Intended use(s)

EAD 332347-00-0601 applies. In addition, the connector is intended to be used when subjected to seismic actions.

Furthermore, this EAD covers methods to assess the edge distance to prevent splitting under load in existing concrete, $c_{cr,sp,ex}$, as indicated in Table 2.1.1 (lines 6 and 12); thus, this is not a default condition as given in clause 1.2.1 of EAD 332347-00-0601 [1].

1.2.2 Working life/Durability

EAD 332347-00-0601 [1], applies.

1.3 Specific terms used in this EAD

1.3.1 Abbreviations

EAD 332347-00-0601 [1], applies. In addition:

C1	=	seismic performance category C1 (use in design according to EN 1992-4 [7])
C2	=	seismic performance category C2 (use in design according to EN 1992-4 [7])

1.3.2 Notation

EAD 332347-00-0601 [1], applies. In addition:

α_{seis}	=	seismic reduction factor of the shear resistance of the interface
$\alpha_{seis,1}$	=	reduction factor of peak resistance due to cyclic loading
$\alpha_{seis,2}$	=	reduction factor due to non-symmetric response in the two loading directions
$\alpha_{seis,3}$	=	reduction factor due to in-cycle response degradation
$\beta_{cv,seis}$	=	reduction factor resulting from large coefficients of variation
$f_{c,t}$	=	minimum value between the cylindrical compressive strength of the two concrete members (existing and overlay) cast at different times
R_t	=	roughness level
s	=	shear displacement
V_u	=	maximum shear resistance
$V_{u,cyc,1}$	=	peak resistance in the loading direction (first cycle) where the maximum resistance is recorded, see Figure 2.2.1.3.1

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

$V_{u,max,1}$ = peak resistance in the loading direction (first cycle) where the maximum resistance is recorded, see Figure 2.2.1.3.2

$V_{u,min,1}$ = peak resistance in the loading direction (first cycle) where the minimum resistance is recorded, see Figure 2.2.1.3.2

$V_{u,ave,1}$ = peak resistance at the first cycle calculated averaging the peaks recorded in the two loading directions, see Figure 2.2.1.3.3 and equation (2.2.1.3.7)

$V_{u,ave,3}$ = peak resistance at the third cycle calculated averaging the peaks recorded in the two loading directions, see Figure 2.2.1.3.3 and equation (2.2.1.3.7)

1.3.3 Indices

EAD 332347-00-0601 [1] applies. In addition:

m = Mean value

mon = Value under monotonic loading

cyc = Value under cyclic loading

1.3.4 Definitions

EAD 332347-00-0601 [1] applies. For clarification and in addition:

Anchor head = EAD 332347-00-0601 [1], Figure 1.1.5

Shaped head = EAD 332347-00-0601 [1], Figure 1.1.5

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 the connector for strengthening of existing concrete structures by concrete overlay 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			
Existing concrete; post-installed **concrete screw**			
Characteristic resistance to tension load (static and quasi-static loading)			
1	Resistance to steel failure	EAD 330232-01-0601 [2], clause 2.2.1	Level $N_{Rk,s,ex}$ [kN], E_s [N/mm²]
2	Resistance to pull out failure	EAD 330232-01-0601 [2], clause 2.2.2	Level $N_{Rk,p,ex}$ [kN], $\psi_{c,ex}$ [-]
3	Resistance to concrete cone failure	EAD 330232-01-0601 [2], clause 2.2.3	Level $k_{cr,N,ex}$, $k_{ucr,N,ex}$ [-], $h_{ef,ex}$, $c_{cr,N,ex}$ [mm]
4	Robustness	EAD 330232-01-0601 [2], clause 2.2.4	Level γ_{inst} [-]
5	Minimum edge distance and spacing	EAD 330232-01-0601 [2], clause 2.2.5	Level $c_{min,ex}$, $s_{min,ex}$, $h_{min,ex}$ [mm]
6	Edge distance to prevent splitting under load	EAD 330232-01-0601 [2], clause 2.2.6	Level $c_{cr,sp,ex}$ [mm]
Characteristic tension resistance for seismic performance categories C1 and C2			
7	Resistance to tension load C1	EAD 330232-01-0601 [2], clause 2.2.11	Level $N_{Rk,s,C1,ex}$ [kN], $N_{Rk,p,C1,ex}$ [kN]
8	Resistance to tension load C2	EAD 330232-01-0601 [2], clause 2.2.12	Level $N_{Rk,s,C2,ex}$ [kN], $N_{Rk,p,C2,ex}$ [kN]
Existing concrete; post-installed **bonded** fastener			
Characteristic resistance to tension load (static and quasi-static loading)			
9	Resistance to steel failure	EAD 330499-01-0601 [3], clause 2.2.1	Level $N_{Rk,s,ex}$ [kN]
10	Resistance to pull out and concrete failure	EAD 330499-01-0601 [3], clauses 2.2.2	Level τ_{Rk} [N/mm²], $\psi_{c,ex}$ [-]
11	Resistance to concrete cone failure	EAD 330499-01-0601 [3], clause 2.2.3	Level $c_{cr,N,ex}$ [mm], $k_{cr,N,ex}$, $k_{ucr,N,ex}$ [-]
12	Edge distance to prevent splitting under load	EAD 330499-01-0601 [3], clause 2.2.4	Level $c_{cr,sp,ex}$ [mm]
13	Robustness	EAD 330499-01-0601 [3], clause 2.2.5	Level γ_{inst} [-]
14	Minimum edge distance and spacing	EAD 330499-01-0601 [3], clause 2.2.6	Level $c_{min,ex}$, $s_{min,ex}$, $h_{min,ex}$ [mm]
Characteristic tension resistance for seismic performance categories C1 and C2			
15	Resistance to tension load C1	EAD 330499-01-0601 [3], clause 2.2.11	Level $N_{Rk,s,C1,ex}$ [kN], $\tau_{Rk,C1,ex}$ [N/mm²]

No	Essential characteristic	Assessment method	Type of expression of product performance
16	Resistance to tension load C2	EAD 330499-01-0601 [3], clause 2.2.12	Level $N_{Rk,s,C2,ex}$ [kN], $\tau_{Rk,\,C2,ex}$ [N/mm²]
Concrete overlay; cast-in fastener			
Characteristic resistance to tension load (static and quasi-static loading)			
17	Characteristic resistance to steel failure for cast-in fastener in concrete overlay	EAD 332347-00-0601 [1], clause 2.2.1	Level $N_{Rk,s,ov}$ [kN]
18	Characteristic resistance to pull-out failure for cast-in fastener in concrete overlay under static and quasi-static tension loading	EAD 332347-00-0601 [1], clause 2.2.2	Level For anchor heads: A_h [mm²], t_h [mm] For shaped heads: $N_{Rk,p,ov}$ [kN], $\psi_{c,ov}$ [-]
19	Characteristic resistance to concrete cone failure for cast-in fastener in concrete overlay under static and quasi-static tension loading	EAD 332347-00-0601 [1], clause 2.2.3	Level $c_{cr,N,ov}$ [mm], $h_{ef,ov}$ [mm] $k_{cr,N,ov}$, $k_{ucr,N,ov}$ [-]
20	Resistance to blow-out failure and edge distances and spacing	EAD 332347-00-0601 [1], clause 2.2.4	Level A_h [mm²] $c_{min,ov}$, $s_{min,ov}$ $h_{min,ov}$ [mm] $c_{cr,sp,ov}$ [mm]
Characteristic tension resistance for seismic performance categories C1 and C2 1)			
23	Resistance to tension load C1	EAD 330232-01-0601 [2], clause 2.2.11	Level $N_{Rk,s,C1,ov}$ [kN]; $N_{Rk,p,C1,ov}$ [kN]
24	Resistance to tension load C2	EAD 330232-01-0601 [2], clause 2.2.12	Level $N_{Rk,s,C2,ov}$ [kN]; $N_{Rk,p,C2,ov}$ [kN]
Shear interface parameters under **static and quasi-static, fatigue and seismic cyclic** loading			
25	Shear interface parameters under static and quasi-static and fatigue loading	EAD 332347-00-0601 [1], clause 2.2.5	Levelα_{k1} [-], f_{yk} [N/mm²], α_{k2} [-], A_s [mm²], η_{sc} [-]
28	Factor for seismic cyclic loading	clause 2.2.1	Level α_{seis} [-]
Basic Works Requirement 2: Safety in case of fire			
29	Reaction to fire	EAD 332347-00-0601 [1], clause 2.2.6	Class

1) No testing required if it can be shown that the resistance of the connector for static and quasi-static loading in the existing concrete is equal to or smaller than the resistance of the connector in the new concrete. In this case the values $N_{Rk,s,C1,ex}$, $N_{Rk,p,C1,ex}$, $N_{Rk,s,C2,ex}$, $N_{Rk,p,C2,ex}$ shall be taken for the concrete overlay as well.

Note: Seismic assessment as per EAD 330232-01-0601 [2] covers post-installed mechanical fasteners only but can be applied to establish the seismic tension performance for categories C1 and C2 for cast-in anchors with head or shaped head.

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.

2.2.1 Factor for seismic cyclic loading

2.2.1.1 Monotonic reference tests (Series R1 and R2 according to Annex A, Table A.1.1)

Purpose of the assessment

The tests are required to provide a monotonic reference of a standardized interface crossed by the connectors for which the assessment is sought.

Assessment method

The test shall be performed with connector sizes s/m/l (see definition in EAD 332347-00-0601 [1], Table A.1.2). The tests shall be conducted with concrete and interface roughness in accordance with clause A.3.2.2

The shear slip shall be measured at the interface as shown in Figure A.3.1.2. The maximum shear resistance $V_{u,mon}$ determined in accordance with clause A.3.3.2 shall be recorded. The mean values from at least 3 repetitions, $V_{um,mon}$, shall be calculated. If the scatter associated to $V_{um,mon}$ is higher than 15%, the number of repetitions shall be increased until this requirement is met.

2.2.1.2 Cyclic tests (Series 1 and 2 according to Annex A, Table A.1.1)

Purpose of the assessment

These tests are conducted to quantify the effect of an imposed alternating shear slip on a standardized interface crossed by connectors for which the assessment is sought.

Assessment method

The test shall be performed with connector sizes s/m/l (as per definition of EAD 332347-00-0601 [1], Table A.1.2). For each connector the same sizes and embedment lengths tested under monotonic loading (see clause 2.2.1.1) shall be tested under cyclic loading as well. General provisions for test specimens and test setup are given in clause A.3.1. The tests shall be conducted with concrete and interface roughness in accordance with clause A.3.2.2. The tests shall be conducted with increasing shear slip levels with the following steps:

0,05 mm; 0,1 mm; 0,2 mm; 0,4 mm; 0,7 mm; 1,0 mm; 1,5 mm; 2,0 mm; 3,0 mm.

Three cycles at each shear slip level shall be conducted as shown in Figure 2.2.1.2.1. The test shall be stopped, when the displacement level s_{max} is reached, where s_{max} is defined as the minimum of the two following values:

(1) The slip level where the load value drops down to 80% of its peak value in the post-peak region
(2) 3,0 mm

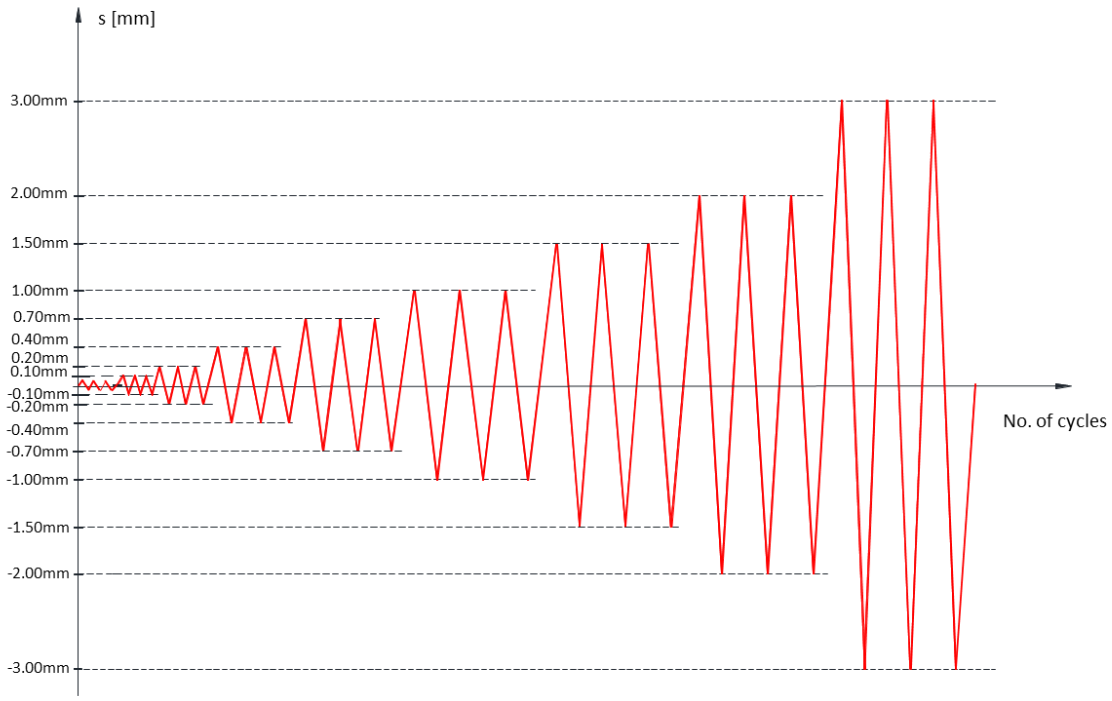


Figure 2.2.1.2.1: Shear slip-controlled loading history in cases where s_{max}=3,0mm.

2.2.1.3 Determination of reduction factor for seismic cyclic loading

The assessment of the hysteretic behaviour of the interface crossed by the connectors for which the assessment is sought shall be carried out to derive the reduction factor α_{seis} as follows:

$$\alpha_{seis} = \beta_{cv,seis} \cdot \alpha_{seis,1} \cdot \alpha_{seis,2} \cdot \alpha_{seis,3} \qquad (2.2.1.3.1)$$

where:

$\alpha_{seis,1}$ = reduction of peak resistance due to cyclic loading (see Figure 2.2.1.3.1 and equation (2.2.1.3.4)

$\alpha_{seis,2}$ = reduction due to non-symmetric response in the two loading directions (see Figure 2.2.1.3.2 and equation (2.2.1.3.6)

$\alpha_{seis,3}$ = reduction due to in-cycle response degradation (see Figure 2.2.1.3.3 and equation 2.2.1.3.8)

$$\beta_{cv,seis} = min\{\beta_{cv,seis,1};\ \beta_{cv,seis,2}; \beta_{cv,seis,3}\} \qquad (2.2.1.3.2)$$

where:

$\beta_{cv,seis,1}$ = reduction factor resulting from large coefficients of variation of $V_{u,cyc,1,i}$ according to clause A.3.3.4

$\beta_{cv,seis,2}$ = reduction factor resulting from large coefficients of variation of factor $\alpha_{seis,2}$ according to clause A.3.3.4

$\beta_{cv,seis,3}$ = reduction factor resulting from large coefficients of variation of factor $\alpha_{seis,3}$ according to clause A.3.3.4

The reduction factors $\alpha_{seis,1}$, $\alpha_{seis,2}$ and $\alpha_{seis,3}$ shall be calculated as follows.

The reduction factor $\alpha_{seis,1}$ is given by (see Figure 2.2.1.3.1):

$$\alpha_{seis,1,i} = \frac{V_{u,cyc,1,i}}{V_{um,mon}} \qquad (2.2.1.3.3)$$

$$\alpha_{seis,1} = \frac{1}{n} \cdot \sum_{i=1}^{n} \alpha_{seis,1,i} \tag{2.2.1.3.4}$$

where:

$V_{u,cyc,1,i}$ = peak resistance in the loading direction (first cycle) where the maximum resistance is recorded, measured in each test, *i*

$V_{um,mon}$ = mean peak resistance calculated from the monotonic reference tests

$V_{um,mon} = \frac{1}{n} \cdot \sum_{i=1}^{n} V_{u,mon,i}$ being $V_{u,mon,i}$ the peak resistance in each test, *i*, of the series R1 or R2 as per Table A.1.1

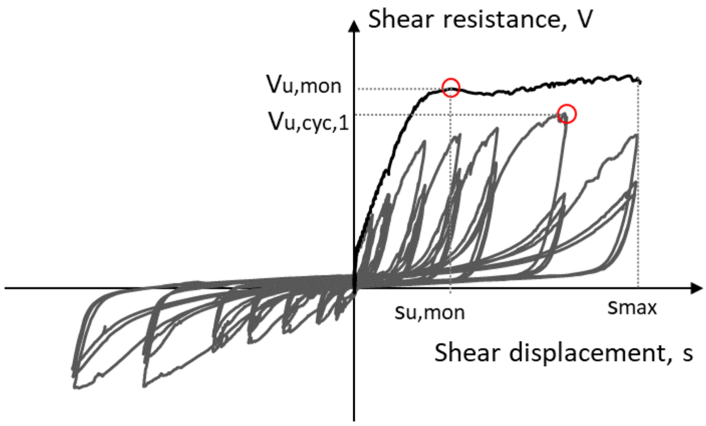


Figure 2.2.1.3.1:
Schematic representation of the values needed to calculate the reduction factor $\alpha_{seis,1}$

The reduction factor $\alpha_{seis,2}$ is given by (see Figure):

$$\alpha_{seis,2,i} = \frac{|V_{u,max,1,i}| + |V_{u,min,1,i}|}{2 \cdot |V_{u,max,1,i}|} \tag{2.2.1.3.5}$$

$$\alpha_{seis,2} = \frac{1}{n} \cdot \sum_{i=1}^{n} \alpha_{seis,2,i} \tag{2.2.1.3.6}$$

where:

$|V_{u,max,1,i}|$= peak resistance in the loading direction (first cycle) where the maximum resistance is recorded taken without sign (i.e., absolute value), measured in each test, *i*

$|V_{u,min,1,i}|$= peak resistance in the loading direction (first cycle) where the minimum resistance is recorded taken without sign (i.e., absolute value) measured in each test, *i*

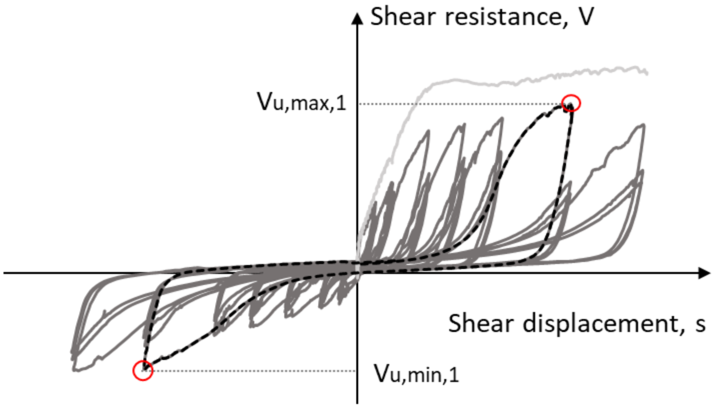


Figure 2.2.1.3.2:
Schematic representation of the values needed to calculate the reduction factor $\alpha_{seis,2}$

The reduction factor $\alpha_{seis,3}$ is given by (see Figure):

$$\alpha_{seis,3,i} = \frac{V_{u,ave,3,i}}{V_{u,ave,1,i}} \quad (2.2.1.3.7)$$

$$\alpha_{seis,3} = \frac{1}{n} \cdot \sum_{i=1}^{n} \alpha_{seis,3,i} \quad (2.2.1.3.8)$$

where:

$V_{u,ave,1}$ = peak resistance at the first cycle calculated averaging the peaks recorded in the two loading directions measured in each test, *i*

$V_{u,ave,3}$ = peak resistance at the third cycle calculated averaging the peaks recorded in the two loading directions measured in each test, *i*

$V_{u,ave,i} = \frac{|V_{u,max,i}|+|V_{u,min,i}|}{2}$ with *i* = 1 or 3

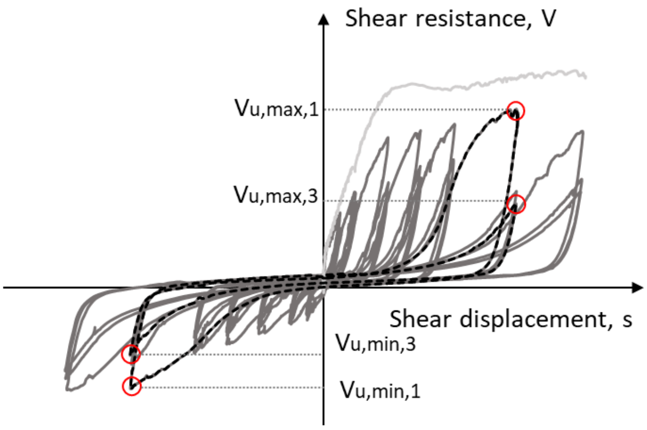


Figure 2.2.1.3.3:
Schematic representation of the values needed to calculate the reduction factor $\alpha_{seis,3}$

Expression of results

The reduction factor α_{seis}, calculated with equation (2.2.1.3.1), shall be reported 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

EAD 332347-00-0601 [1] applies.

3.2 Tasks of the manufacturer

EAD 332347-00-0601 [1], Table 3.2.1 applies.

3.3 Tasks of the notified body

EAD 332347-00-0601 [1], Table 3.3.1 applies.

4 REFERENCE DOCUMENTS

EAD 332347-00-0601 [1] applies. In addition:

[1]	EAD 332347-00-0601: 2018-12	Connector for strengthening of existing concrete structures by concrete overlay
[2]	EAD 330232-01-0601: 2019-12	Mechanical fasteners for use in concrete
[3]	EAD 330499-01-0601:2018-12	Bonded fasteners for use in concrete
[4]	EOTA TR 066: 2020-11	Design and requirements for construction works of post-installed shear connection for two concrete layers
[5]	ISO 5468:2017	Rotary and rotary impact masonry drill bits with hard metal tips – Dimensions
[6]	EN ISO 13473-1:2019	Characterization of pavement texture by use of surface profiles – Part 1: Determination of mean profile depth
[7]	EN 1992-4	Eurocode 2 – Design of concrete structures – Part 4: Design of fastenings for use in concrete

For further information:

[8]	Palieraki V., Vintzileou E.	“Cyclic Behaviour of Interfaces in Repaired/Strengthened RC Elements”, Journal "Architecture – Civil Engineering – Environment ACEE" Journal, Vol. 2, No. 1/2009, pp. 97-108.

ANNEX A TEST PROGRAM AND GENERAL ASPECTS OF ASSESSMENT

A.1 Test program

The test program to determine the overlay shear resistance under seismic loading is given in Table A.1.1. Detailed information concerning the tests is given in the corresponding clause referred to in this table.

The tests with smooth interface may be omitted, if the factor α_{seis} determined for rough interfaces is used for smooth interfaces as well. The roughness level R_t shall be R_t = 3,0 ± 0,5 mm and R_t ≤ 1,0 mm for rough and smooth interfaces, respectively. See also the provision in clause A.3.2.2.

The assessment is valid for the tested embedment in the existing concrete and in the overlay but can be conservatively extended for longer embedment lengths. If tests with minimum and maximum embedment lengths are conducted, the assessment for intermediate embedment lengths can be done via a linear interpolation, if the failure mode of the connectors of the interfaces does not change. Alternatively, the assessment for a certain embedment length can be applied to larger embedment lengths. This is valid for both anchorage lengths in existing concrete and overlay.

The post-installed fasteners shall be installed using the drilling method and drill nominal diameter specified by the manufacturer with a medium cutting diameter $d_{cut,m}$ in accordance with **Fehler! Verweisquelle konnte nicht gefunden werden.**Table A.3.3.2.1.

Table A.1.1 Test program for concrete overlays under seismic loading

No	Purpose of test	Concrete strength class	Roughness	Size to be tested 1)	$h_{ef,ex}$ and $h_{ef,ov}$	n_{min}	Clause
Resistance of the interface to seismic loading							
R1	Reference interface monotonic test	Existing concrete: C20/25 Overlay ≥ C20/25	Rough	s/m/l	Min/Max	3	2.2.1
R2			Smooth	s/m/l	Min/Max	3	
1	Cyclic interface test		Rough	s/m/l	Min/Max	5	
2			Smooth	s/m/l	Min/Max	5	

1) "s/m/l" in accordance with EAD 332347-00-0601 [1], Table A.1.2

Note: the use of a concrete strength class higher than C20/25 is recommended for cases where the effective embedment length in the new concrete is smaller than 30% of its thickness.

A.2 General aspects of assessment

Clauses A.2 to A.8 of EAD 332347-00-0601 [1] are still valid, when applicable.

A.3 Seismic tests for shear connection

A.3.1 General provisions for test specimens and setup

An example of specimen for testing is shown in Figure A.3.1.1, while the test-setup is schematically shown in Figure A.3.1.2. With reference to these figures, the test specimens and setup shall fulfil the following requirements:

1. Minimum interface reinforcement shall be kept to prevent sudden failure at the moment a crack occurs along the interface (according to TR 066 [4]).
2. Three connectors shall be installed in a row parallel to the loading direction to limit rotation of the specimen during testing due to loss of stiffness in one loading direction.
3. Minimum cover and spacing between connectors shall be kept to prevent the occurrence of splitting cracks (c ≥ 5d parallel and c ≥ 4,5d perpendicular to the loading direction, clear distance between consecutive connectors ≥ 5d, d being the diameter of the connectors). These minimum values shall be accordingly increased, if the minimum spacing and edge distances (s_{min} and c_{min}) for the considered connector are larger.
4. Adequate secondary reinforcement shall be installed to prevent failures outside of the interface region except in proximity of the interface to prevent favourable effect on the behaviour of the interface (see Figure A.3.1.1 c)).
5. Geometry of the specimen shall be such to allow for the application of cyclic shear slip with zero eccentricity in order to subject the interface to pure shear; reduction of the width of the specimen close the interface between the concrete blocks cast at different times is needed to force the crack to pass through the plane of the interface (Figure A.3.1.1 a)).
6. Displacement controlled cyclic shear slips shall be applied to allow for post-peak behaviour to be continuously recorded and imposed at low speed to avoid dynamic effects (i.e., max. 0,1 mm/min up to peak resistance with possible increase in the post-peak branch). The shear slip loading rate shall be controlled with the aid of displacement devices at the interface (it is suggested to use two displacement transducers located on each side of the interface, as shown by point (3) in Figure A.3.1.2).
7. The dimensions of the specimen shown in Figure A.3.1.1 a) and b) as a function of the nominal diameter of the connectors (d) and their nominal embedment length ($h_{nom,ex}$ and $h_{nom,ov}$) fulfil these requirements.
8. Two vertical constraints shall be used to limit rotation (but not the horizontal translation) of the specimen during testing, (point (7) in Figure A.3.1.2). The supports shall be placed at a maximum distance of L/6 from the ends of specimen, with L according to the definition given in Figure A.3.1.1 a).

   Note: If a shear friction resistance of the interfaces higher than 500 kN is expected, an increase of the amount of the constructive reinforcement might be needed.

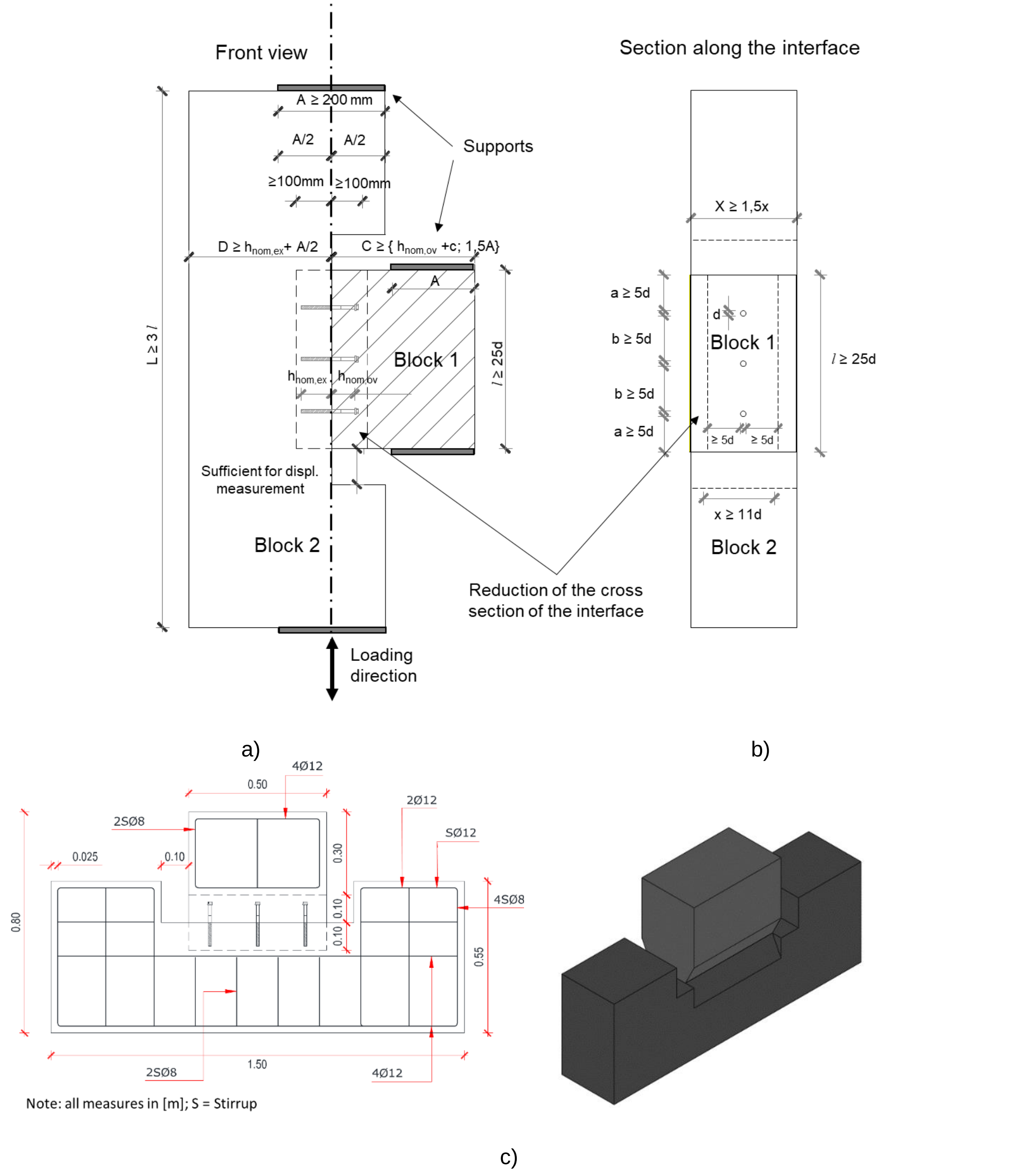
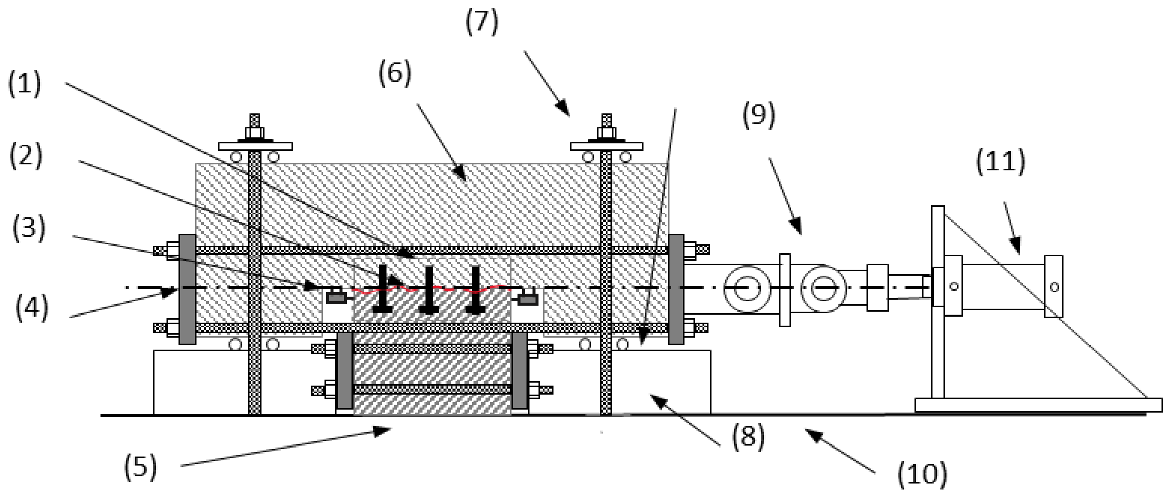


Figure A.3.1.1: Example of specimen for testing of monotonic and cyclic shear-friction interface resistance



Legend:

(1) Connectors under investigation;
(2) Interface under investigation;
(3) Displacement transducer;
(4) Steel plates fixed with threaded rods;
(5) Reinforced concrete member simulating the concrete overlay;
(6) Reinforced concrete element simulating the existing member;
(7) Vertical constraints (roller bearing + PFTE layer);
(8) Support to allow relative slip between existing member and overlay;
(9) Hinged connection;
(10) Strong floor;
(11) Load cell and cylinder.

Figure A.3.1.2: Example of test setup for seismic testing of shear interfaces

A.3.2 Test members, setup and execution

For tests in accordance with Table A.1.1, the parts of the members simulating the existing concrete and the overlay shall be made of concrete with compressive strength of the strength class C20/25 for the existing concrete and at least C20/25, but not higher than C50/60, for the overlay.

A.3.2.1 Casting and curing of test members

The provisions of EAD 332347-00-0601 [1], A.2.2.8 applies.

However, the parts of the member simulating the existing concrete and the overlay are cast at different times. It is allowed to cast the overlay 21 days after casting the existing concrete. When testing the interface, the concrete of the overlay shall be at least 21 days old.

The schematic workflow shown in EAD 332347-00-0601 [1], Figure A.7.3.1 applies.

A.3.2.2 Interface roughness

<u>Tests with rough interface</u>

The surface roughness for the test series with rough interface shall be in the range of R_t = 3,0 mm ± 0,5 mm.

<u>Tests with smooth interface</u>

If the first part of the specimen is cast with the interface against the formwork, no roughness measurement is needed. If the interface is on the untreated side, the surface roughness for the test series with smooth interface shall be R_t < 1,0 mm.

<u>Roughness measurement</u>

The measurement shall be in accordance with the sand patch method (reference [10] of EAD 332347-00-0601) [1] or the mean profile depth in accordance with [6]. A minimum of two measurements per each specimen is required.

A.3.2.3 Installation of the connectors

The connectors shall be installed in accordance with the Manufacturer's Product Installation Instruction. The installation shall be conducted at normal ambient temperature (21°C ± 3°C).

The holes for connectors shall be perpendicular (± 5° deviation) to the surface of the concrete member.

In the tests, the drilling tools specified by the manufacturer for the fasteners shall be used. If hard metal hammer-drill bits are required, these bits shall meet the requirements laid down in ISO 5468 [5] with regard to dimensional accuracy, symmetry, symmetry of insert tip, height of tip and tolerance on concentricity.

The diameter of the cutting edges as a function of the nominal drill bit diameter is given in Figure A.3.2.3.1. In Table A.1 the medium drill bit cutting diameter ($d_{cut,m}$) as specified in Figure A.3.2.3.1 is required for all the test series.

The diameter of the drill bit shall be checked every 10 drilling operations to ensure continued compliance.

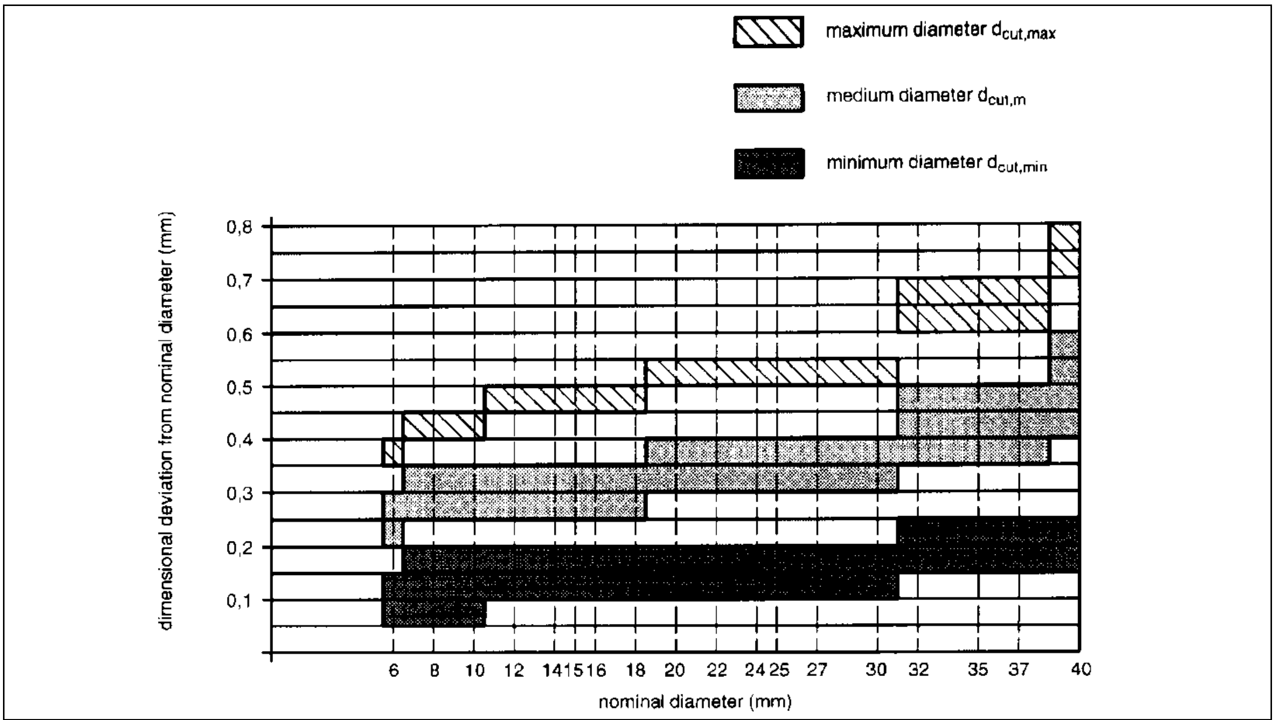


Figure A.3.2.3.1: Cutting diameter of hard metal hammer-drill bits

A.3.3 Assessment

A.3.3.1 Conversion of failure loads to nominal strength

The conversion of failure loads shall be done according to equation (A.3.3.1.1):

$$V_{u,20} = V_{u,t} \cdot \frac{20}{f_{c,t}} \quad \text{(A.3.3.1.1)}$$

where:

$f_{c,t}$ = is the minimum value between the cylindrical compressive strength of the two concrete members cast at different times. If cubic concrete compressive strength is measured, the appropriate conversion factor shall be taken into account.

Note: The use of a linear interpolation for the normalization of the shear resistance of the interface is a conservative approach, as proven by experimental evidence ***Fehler! Verweisquelle konnte nicht gefunden werden.****. A more precise analytical formulation is not possible because the influence of concrete compressive strength is different for friction and dowel action as well as for different combinations compressive strength of the two concrete members cast at different times.*

A.3.3.2 Monotonic peak shear resistance and slip

For the determination of the peak resistance and corresponding slip, the rules displayed in Figure A.3.3.2.1 shall be followed.

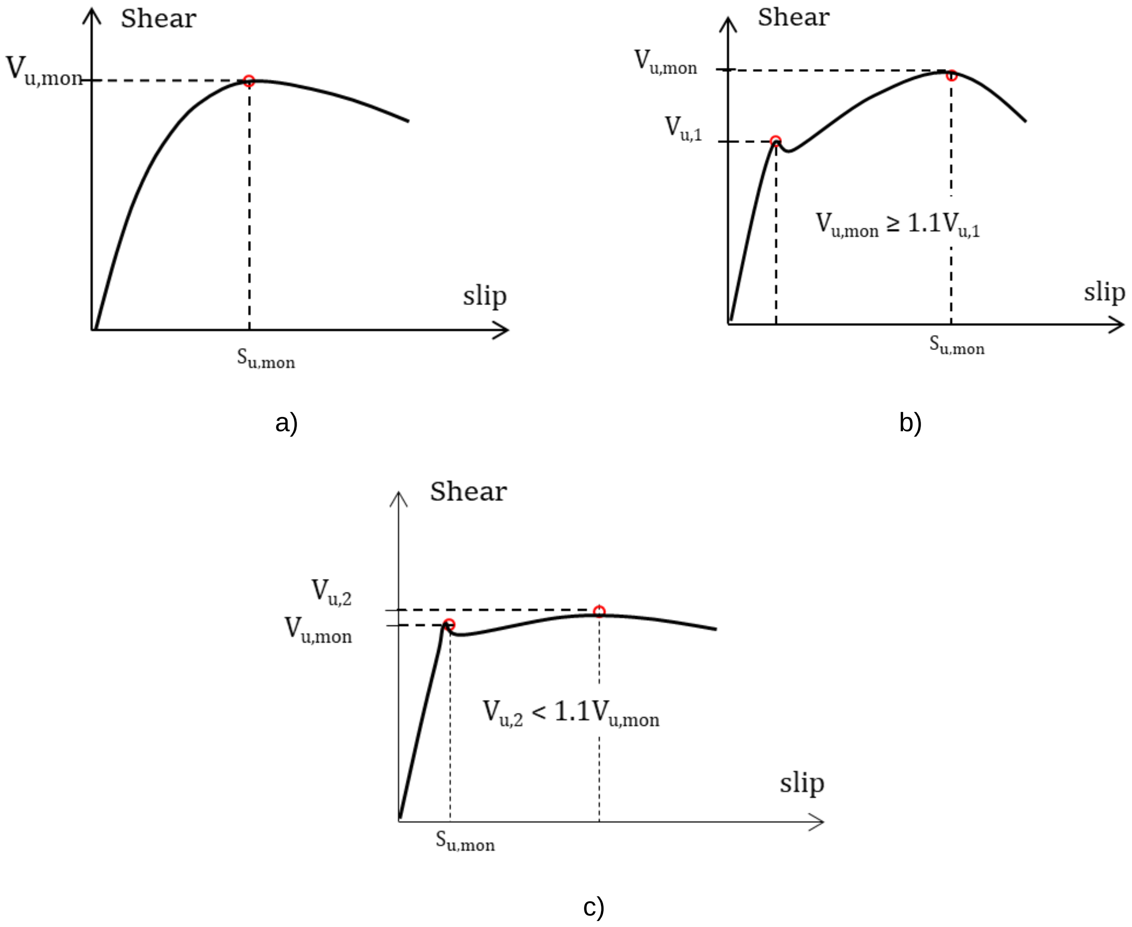


Figure A.3.3.2.1:
Rules for the determination of the shear peak resistance and related slip in the monotonic reference tests

A.3.3.3 Cyclic loads (reduction factors $\alpha_{seis,1}$, $\alpha_{seis,2}$ and $\alpha_{seis,3}$)

For the test series in accordance with Table A.1.1, lines 1 and 2, the mean failure loads shall be compared with the corresponding reference test series. The reduction factors $\alpha_{seis,1}$, $\alpha_{seis,2}$ and $\alpha_{seis,3}$ shall be calculated as explained in clause 2.2.1.3.

A.3.3.4 Criteria regarding scatter of loads

If the coefficient of variation of the factors $\alpha_{seis,1}$, $\alpha_{seis,2}$ and $\alpha_{seis,3}$ ($\beta_{cv,seis,1}$, $\beta_{cv,seis,2}$ and $\beta_{cv,seis,3}$, respectively) calculated for each test of the series according to Table A.1.1, lines 1 and 2 exceeds 20 %, the following reduction shall be taken into account:

$$\beta_{cv,i} = \frac{1}{1+0{,}03\,(cv_i - 20)} \leq 1{,}0 \text{ with i = 1 to 3} \qquad \text{(A.3.3.4.1)}$$

The smallest value of $\beta_{cv,i}$ shall be considered in the assessment.