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European Assessment Document for

Glued-in rods for timber connections

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

Glued-in rods for timber connections (in the following referred to as glued-in rods) are composed of metallic threaded rods glued in timber elements with an adhesive.

The following components are part of the kit:

- Metallic threaded rods made of carbon steel according to EN ISO 898-1[1] or stainless steel according to EN ISO 3506-1 or
- weldable reinforcing steel bars (rebars) in accordance with EN 10080

and

- a two-component epoxy adhesive or
- a two-component polyurethane adhesive stated according to this document and EN 923.

This EAD covers rods

- with diameters 6 mm ≤ d ≤ 30 mm, and
- a minimum bonded length of the glued-in rods $l_{a,min}$ of 10 · d but always ≥ 100 mm, and
- with minimum spacing for glued-in rods according to EN 1995-1-1, Table 8.5, and
- with a minimum edge distance a_4 of at least 2,5 · d,
- with documented inorganic surface finish of the materials, including anti-corrosive protection, and
- in accordance with the Commission Decision 96/603/EC, as amended by Commission Decision 2000/605/EC and Commission Decision 2003/424/EC.

This EAD covers adhesives

- with bond line thicknesses between t_b ≤ 3 mm (total bond line thickness t_B = ≤ 6 mm) reached for example by spacers. Hereby, the diameter of the drill hole is at least 2 mm and no more than 6 mm wider than the rod diameter.
- that fulfil the provisions given in EN 17334, 7.2.1.
- that fulfil the provisions in EN 301, Table 5, for high temperature.
- that fulfil the provisions in EN 301, Clause 5.5.
- that fulfil the provisions in EN 301, Clause 5.6.

This EAD covers adhesives with working properties assessed according to EN 17334, Clause 11:

- working life under referenced conditions assessed in accordance with EN 17334, Clause 11.2, and
- open assembly time assessed in accordance with EN 17334, Clause 11.3, and
- curing time under reference conditions assessed in accordance with EN 17334, Clause 11.4, and
- time to fully cured state of the connection assessed in accordance with EN 17334, Clause 11.5.

The following timber elements which are connected by the glued-in rods are not necessarily supplied by the manufacturer but part of assembled system at the building site:

- Glued laminated timber (GLT) or glued solid timber (GST) according to EN 14080 or glued laminated timber of hardwood;
- Solid wood members of softwood or hardwood according to EN 14081-1. Hereby, the maximum width and height of the solid wood members may be limited due to possibility of cracks;
- Cross laminated timber (CLT) according to EN 17334, Clause 8.2.2.3;
- Laminated veneer lumber (LVL) made of softwood or hardwood according to EN 14374;
- Glued laminated timber made from laminated veneer lumber LVL of softwood or hardwood.

The EAD covers timber connections with glued-in rods prefabricated under factory or factory-like conditions.

This EAD also covers glued-in rods in surface treated wood. It does not cover glued-in rods in modified and stabilized wood with considerably reduced swelling and shrinkage properties.

Examples for installation of glued-in rods are shown in Figure 1.1.1.

[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.

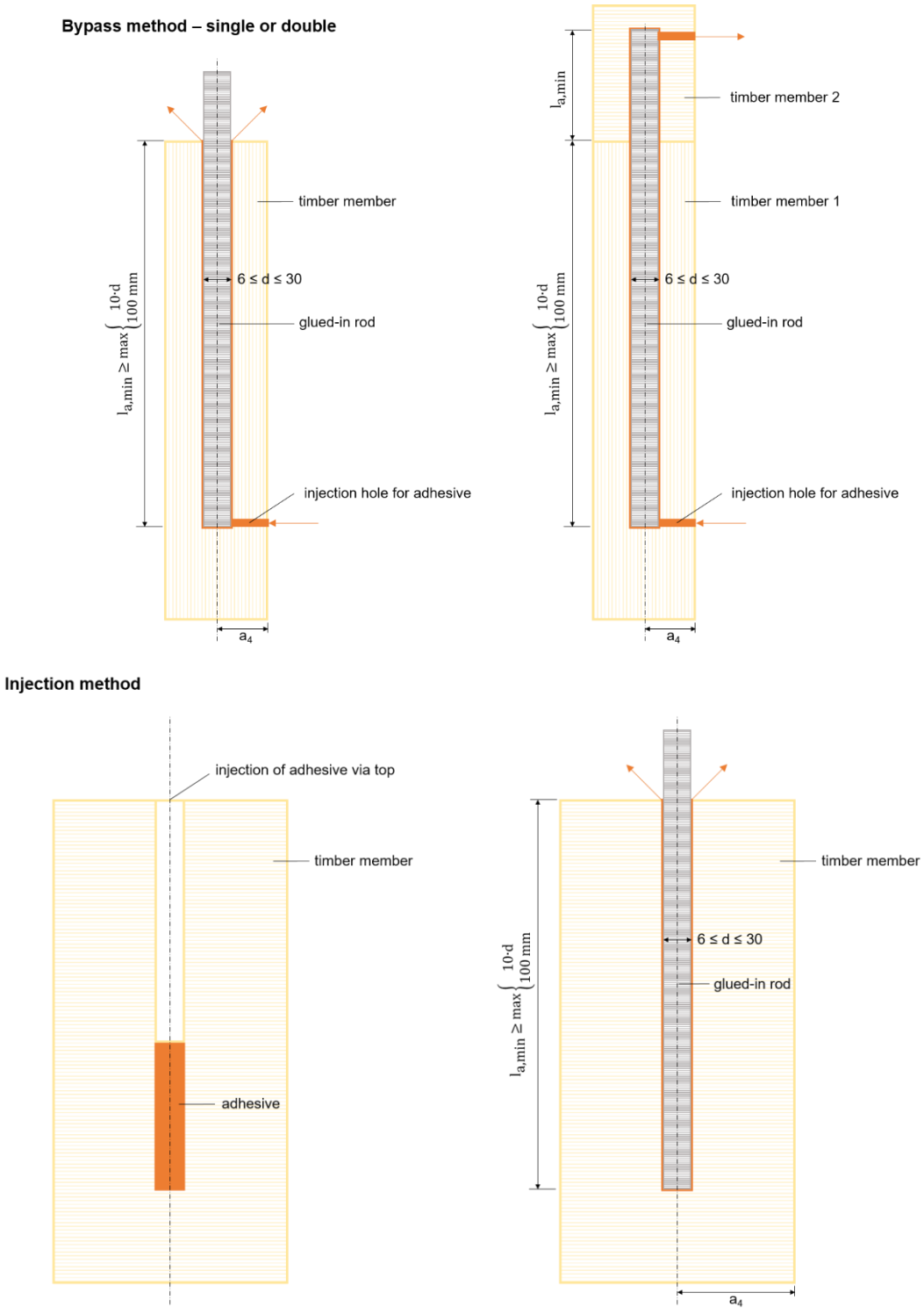

Figure 1.1.1: Example for installation of glued-in rods

The product is not covered by a harmonised European standard (hEN).

The product is not fully covered by the non-harmonised standard EN 17334, see Clause 2.2.1.

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 product installation instructions (MPII) 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(s) of the construction product

1.2.1 Intended use

The glued-in rods are intended to be used in load-bearing timber-to-timber, timber to concrete, timber-to-metal connections, or as reinforcement rods. The glued-in rods are mainly loaded in tension or compression. Examples for the intended use of glued-in rods are shown in Figure 1.2.1.1.

The glued-in rods are only intended to be used subject to static or quasi-static actions.

The glued-in rods are intended to be used in service class 1 and 2 according to EN 1995-1-1 where the creep deformation factor k_{def} shall be defined according to Table 3.2 of EN 1995-1-1. Due to the brittle failure of a glued-in rods connection $k_{mod,LDY,SCX}$ (determined in Clause 2.2.2) is limited by the value $k_{mod,1min,SCX}$ = 1.0 for very short duration of load.

The glued-in rods are intended for load-bearing timber structures which are not subjected to a prolonged exposure to temperatures over 60 °C (see EN 1995-1-1, Clause 1.1.2 (3)P).

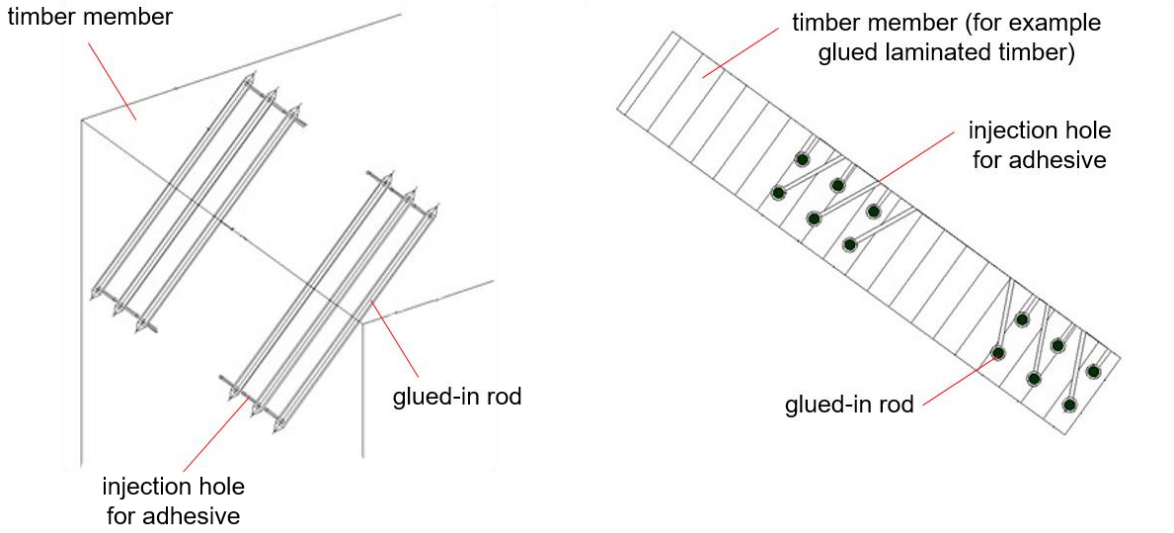

Figure 2.2.1.1: Examples for the intended use of glued-in rods in a timber-to-timber connection

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 glued-in rods for the intended use of 50 years when installed in the works. 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

[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.

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 Glued-in rod

The glued-in rods are metallic threaded or ribbed rods glued in timber elements with an adhesive.

1.3.2 Threaded rod

Rod that is threaded along its entire length.

1.3.3 Ribbed rod

Reinforcing steel rod with at least two rows of transverse ribs which are uniformly distributed over its entire length.

1.3.4 Reinforcement rods

Glued-in rods to prevent from the possibility of splitting caused by a tension force component perpendicular to the grain.

1.3.5 Metal connection

Steel piece designed for timber-to-timber, timber-to-concrete or timber-to-metal connections using glued-in rods.

1.3.6 MPII

Manufacturer's product installation instructions.

1.3.7 Symbols

d	[mm]	nominal diameter of the glued-in rods
t_b	[mm]	bond line thicknesses of the adhesive
t_B	[mm]	total bond line thickness $t_B = 2\ t_b$
$f_{v,lts,Ax,mean}$	[MPa]	mean longitudinal tensile shear strength for treatment Ax (A1 to A7) according to EN 17334, Table 1, first column
D	[%]	delamination determined in tests according to EN 17334, Clause 7.3.2
$f_{v,ws,\ mean}$	[MPa]	mean shear strength effected by wood shrinkage determined in tests according to EN 17334, Clause 7.3.3
$w_{cr,mean}$	[mm]	mean deformation of all bond lines for static loading in compression shear determined in tests according to EN 17334, Clause 7.3.3
$f_{vr,la,tB,k}$	[MPa]	characteristic bond shear strength value of the glued-in rods according to EN 17334, Clause 8
$f_{vr,la,tB,mean}$	[MPa]	mean bond shear strength value of the glued-in rods according to EN 17334, Clause 8
$f_{vr,la,tB,SCX}$	[MPa]	bond shear strength value for service class SCX
$f_{vr,la,tB,res,k}$	[MPa]	characteristic residual bond shear strength value of the glued-in rods according to EN 17334, Clause 9
l_a	[mm]	nominal bonded length of the glued-in rods
$l_{a,min}$	[mm]	minimum bonded length of the glued-in rods
l_m	[mm]	distance between the tips of the opposite glued-in rods
l	[mm]	total length of timber specimen

F	[N]	applied load
a	[mm]	cross-section edge length of specimen
a_4	[mm]	minimum edge distance of the glued-in rods
$f_{h,k}$	[MPa]	characteristic embedment strength of the glued-in rods
$f_{v,k}$	[MPa]	characteristic shear resistance of the glued-in rods
n_{unbrok}	[-]	number of unbroken specimens without indication of tertiary creep according to EN 17334, Clause 10
k_{def}	[-]	factor for the evaluation of creep deformation
R_{SCX}	[-]	ratios determined for different climate conditions related to different service classes as determined in short-term strength tests
t	[min]	time
k	[-]	slope of linear regression
d	[-]	intercept of linear regression
$k_{d,LDY,SCX}$	[-]	relative duration of load capacity
$k_{mod,LDY,SCX}$	[-]	modification factor for duration of load and moisture content

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 glued-in rods 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	Bond strength in longitudinal tensile shear strength	EN 17334, Clause 7.3.1	Level $f_{v,lts,Ax,mean}$ [MPa]
2	Resistance to delamination	EN 17334, Clause 7.3.2	Level D [%]
3	Effect of wood shrinkage on the shear strength	EN 17334, Clause 7.3.3	Level $f_{v,ws,\ mean}$ [MPa]
4	Effect of compression shear and climatic changes	EN 17334, Clause 7.3.4	Level $w_{cr,mean}$ [mm]
5	Bond shear strength of glued-in steel rods	EN 17334, Clause 8, considering Clause 2.2.1 of this EAD	Level $f_{vr,la,tB,k}$ [MPa]
6	Duration of load	2.2.2	Level $k_{mod,LDY,SCX}$ [-]
7	Bond creep rupture test at very high and low moisture content	EN 17334, Clause 10 considering Clause 2.2.1 of this EAD	Level n_{unbrok} [-]
8	Bond temperature resistance	EN 17334, Clause 9 considering Clause 2.2.1 of this EAD	Level $f_{vr,la,tB,res,k}$ [MPa]
Basic Works Requirement 2: Safety in case of fire			
9	Reaction to fire	2.2.3	Class
Basic Works Requirement 3: Hygiene, health and the environment			
10	Formaldehyde	2.2.4	Class

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.

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.

2.2.1 Deviations from EN 17334

Compared to EN 17334, the following changes are introduced in the scope of this EAD:

- minimum edge distance a_4,
- additional timber materials (GLT of hardwood and LVL, solid wood members of softwood or hardwood) to those defined in EN 17334, Clause 8.2.2.2 to 8.2.2.4,
- assessment of duration of load,
- assessment of reaction to fire, and
- assessment of emission of formaldehyde.

Cross section edge length

The cross section edge length according to Equation (1) of EN 17334 shall be substituted by Equation (2.2.1.1) for $a_4 \leq 3{,}75 \cdot d$ in order to reflect the minimum edge distance a_4 specified in MPII (for minimum edge distance a_4 see Figure 1.1.1).

$$a = 2 \cdot a_4 \quad \text{for } a_4 \leq 3{,}75 \cdot d \qquad (2.2.1.1)$$

Considerations for additional timber materials to those defined in EN 17334, Clause 8.2.2.2 to 8.2.2.4

For specimens of additional timber materials the provisions for LVL or wood species with a mean density ≥ 600 kg/m³ and a characteristic density ≥ 500 kg/m³ apply.

For additional GLT timber materials the cross-sectional build-up according to EN 17334, Clause 8.2.2.2, manufacture of bond according to EN 17334, Clause 8.3.1, as well as determination of density and moisture for GLT applies.

If splitting failure of the members occurs, respective test results shall be reported but discarded in the evaluation of the results.

The density correction exponent according to EN 17334, Equation (9) is 0,6 for softwood and 1,0 for hardwood materials.

2.2.2 Duration of load

Purpose of the assessment

The combined effect of duration time and moisture content on the resistance properties shall be taken into account using the $k_{mod,LDY,SCX}$ factors.

Assessment method

The test for assessment of the $k_{mod,LDY,SCX}$ factor shall be performed under the climate conditions of the corresponding service class defined in the EN 1995-1-1, Clause 2.3.1.3. Hereby, the maximum and minimum possible moisture content of the respective service class shall be reached in the interface between glue line and timber member (moisture content of wood is 12% in service class 1, 20% in service class 2).

The respective climates

- (20 ± 2)°C and (65 ± 5)% relative humidity for service class 1 (SC1)
- (20 ± 2)°C and (85 ± 5)% relative humidity for service class 2 (SC2)

shall act on the timber member for at least 50 days until equilibrium moisture content is reached. Equilibrium moisture content is reached when the results of two weightings within 6 hours differ by no more than 0,1% of the mass. The duration until a moisture content of wood of 12%/20% in service class 1/2 is reached is longer for wood species with a high density.

Determination of moisture content and density shall be performed according to EN 17334, Clause 8.3.3, second paragraph. In case of solid wood members of softwood or hardwood the provisions for LVL apply.

1) Short-term strength

The short-term strength is determined according to EN 17334, Clause 8, considering Clause 2.2.1 of this EAD as bond shear strength value $f_{vr,la,tB,SCX}$ separately for each service class for which $k_{mod,LDY,SCX}$ is to be derived. The results are short-term strength values, arranged according to increasing strength within each service class. From these values, the following ratio shall be determined for different climate conditions related to different service classes ($R_{SC1} = 1$):

$$R_{SC2} = \frac{1}{n}\sum_{i=1}^{n}\frac{f_{vr,la,tB,SC2}}{f_{vr,la,tB,SC1}} \qquad (2.2.2.1)$$

with

SC1/2	environmental conditions related to service class 1 or 2
i	index of specimen
$f_{vr,la,tB,SCX}$	bond shear strength value for service class 1 or 2
n	number of specimens

2) Duration of load

Duration of load is determined on specimens according to EN 17334, Clause 8.2, considering Clause 2.2.1 of this EAD.

For evaluation of the modification factors for duration of load and moisture content $k_{mod,LDY,SCX}$ testing of at least 5 symmetric specimens per load level at 3 different load levels shall be performed. The load levels shall be determined from the mean bond shear strength value for each service class $f_{vr,la,tB,mean,SCX}$ for example as 80%, 60% and 40% of $f_{vr,la,tB,mean,SCX}$. The load level shall be modified in accordance with the expected time of failure. 80% to 75% usually leads to failure within 4 to 6 months.

The specimens shall be loaded by a constant tension load and the time to failure t shall be recorded for each load level and service class. In addition the time-deformation plot till rupture shall be recorded.

The time-to-failure values t in minutes are plotted in log10(t) versus load level diagram, see Figure 2.2.2.1. The relative duration of load capacity $k_{d,LDY,SCX}$ is determined from this plot as the linear regression of the tested values as

$$y = kx + d \qquad (2.2.2.2)$$

with

k	slope
d	intercept

From this linear regression equation the $k_{d,LDY,SCX}$ values for load duration classes permanent (50 years or 50Y), long-term (10 years or 10Y), medium-term (6 months or 6M), short-term (1 week or 1W) and very short-term (1 minute or 1min) shall be calculated for the respective service classes.

Figure 2.2.2.1 shows an example for the linear regression and calculated $k_{d,LDY,SCX}$ values. In this example the linear regression curve is determined as

$$y = -9{,}8138 \log10(t) + 101{,}05 \qquad (2.2.2.3)$$

which leads to the following $k_{d,LDY,SCX}$ values for the respective load duration classes

- permanent log10(50Y) = 7,42: $k_{d,50Y,SCX}$ = 28 %
- long-term log10(10Y) = 6,72: $k_{d,10Y,SCX}$ = 35 %
- medium-term log10(6M) = 5,42: $k_{d,6M,SCX}$ = 48 %
- short-term log10(1W) = 4,00: $k_{d,1W,SCX}$ = 62 %
- very short-term log10(1min) = 0,00: $k_{d,1min,SCX}$ = 101 %

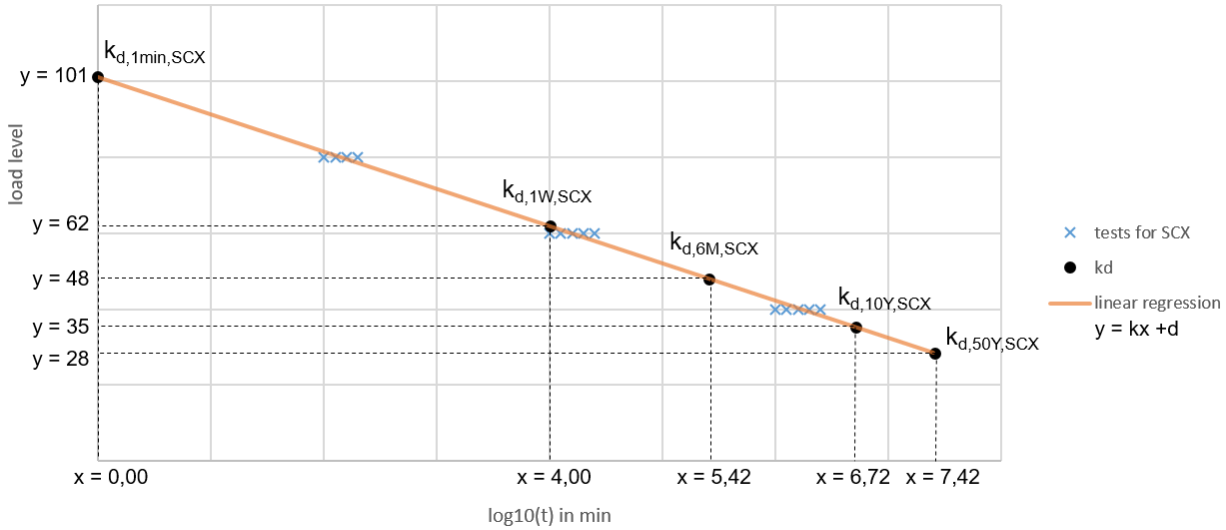

Figure 2.2.2.1: Determination of relative duration of load capacity $k_{d,LDY,SCX}$

The $k_{mod,LDY,SCX}$ values are determined as

$$k_{mod,LDY,SCX} = R_{SCX} \cdot \frac{k_{d,LDY,SCX,LDY}}{100} \qquad (2.2.2.4)$$

with

R_{SC1} = 1 and R_{SC2} as determined in short-term strength tests
SCX environmental conditions related to service class X, 1 ≤ X ≤ 2
LDY load duration, Y = 50 years, 10 years, 6 months, 1 week or 1 minute, respectively

When the determined $k_{mod,LDY,SCX}$ factors are higher than the recommended factors for $k_{mod,LDY,SCX}$ of the relevant timber member given in EN 1995-1-1, Table 3.1, the value of EN 1995-1-1 shall be taken.

As simplified method, it is possible to consider the given values for solid timber and glued laminated timber in Table 3.1 of EN 1995-1-1.

Expression of results

Modification factors for duration of load and moisture content $k_{mod,LDY,SCX}$ factors shall be given in the ETA.

2.2.3 Reaction to fire

The performance of the metallic threaded rods made of steel and the weldable reinforcing steel bars is class A1.

The adhesive (thickness ≤ 3 mm) is located between the rod and the timber element and embedded in the timber element (minimum edge distance a_4 of at least 2,5 · d) in the end use. Therefore, it shall be assumed in the context of the intended use that the contribution of the adhesive in connection with the glued-in rods in the end use application is very small and does not affect the reaction to fire performance of the timber in which the rods are glued-in. Therefore, reaction to fire performance of the adhesive shall be considered as negligible and does not need to be tested.

The following information shall be stated in the ETA:

- reaction to fire class of the metallic threaded rods made of steel and the weldable reinforcing steel bars, and
- statement “reaction to fire performance of the adhesive shall be considered as negligible” due to the reasons given above.

2.2.4 Formaldehyde

Purpose of the assessment and assessment method

Where formaldehyde-containing adhesives are used for the glued-in rods, the content of formaldehyde shall be assessed according to EN ISO 11402.

Two component polyurethane adhesives shall be considered as free of formaldehyde.

Expression of results

For formaldehyde-containing adhesives the free-formaldehyde content $w(CH_2O, \text{free})$ (individual and average values) shall be given in the ETA expressed as percentage per mass.

For adhesives free of formaldehyde, the statement “adhesive contains no added formaldehyde” shall be given in the ETA.

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 97/176/EC, as amended by Commission Decision 2001/596/EC.

The system is 3.

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.

The manufacturer (regarding the components he buys from the market with DoP) shall take into account the Declaration of Performance issued by the manufacturer of that component. No retesting is necessary.

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	Adhesive	Checking of supplier certificates	According to Control plan	1	Each delivery
2	Rods material and geometry	Checking of supplier certificates	According to Control plan	5	Each delivery
3	Timber material and geometry	Checking of supplier certificates	According to Control plan	1	Each delivery
4	Glue line shear resistance	EN 17334, Clause 8	According to Control plan	3	Each change of adhesive batch or at each change of adhesives lots.

4 REFERENCE DOCUMENTS

EN 301:2023	Adhesives, phenolic and aminoplastic, for load-bearing timber structures – Classification and performance requirements
EN 923:2015	Adhesives – Terms and definitions
EN 10080:2005	Steel for the reinforcement of concrete – Weldable reinforcing steel – General
EN 14080:2013	Timber structures – Glued laminated timber – Requirements
EN 14081-1:2005+A1:2011	Timber structures – Strength graded structural timber with rectangular cross section – Part 1: General requirements
EN 14358:2016	Timber structures – Calculation of characteristic 5-percentile values and acceptance criteria for a sample
EN 14374:2004	Timber structures – Structural laminated veneer lumber – Requirements
EN 1995-1-1:2004/AC:2006/A1:2008/A2:2014	Eurocode 5 – Design of timber structures – Part 1-1: general – Common rules and rules for buildings
EN 17334:2021	Glued-in rods in glued structural timber products – Testing, requirements and bond shear strength classification
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
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
EN ISO 11402:2005/AC:2006	Phenolic, amino and condensation resins - Determination of free-formaldehyde content