EUROPEAN ASSESSMENT DOCUMENT

EAD 200002-00-0602

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TENSION ROD SYSTEM

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

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1 SCOPE OF THE EAD

1.1 Description of the construction product

The construction product is a prefabricated tension rod system of different sizes (system sizes) used as a kit. The tension rod system consists of steel bars (tension rods) with external rolled threads which are connected to each other and to the corresponding structure by special connecting devices. The tension rods are either connected to the corresponding structure by steel or cast fork end connectors with two eye loops (incl. pin) and internal thread or by hexagon regular nuts (incl. washer) with corresponding dimensions and threads. The tension rods can be connected to each other by steel or cast threaded sleeves (see Figure 1).

The minimum engagement depth for the tension rods to be screwed in the fork end connectors, hexagon regular nuts and threaded sleeves is such that failure should occur in the tension rod and not in the other components of the tension rod system.

The tension rod system comprises tension rods, fork end connectors or hexagon regular nuts as well as threaded sleeves with metric ISO threads M 6 to M 42.

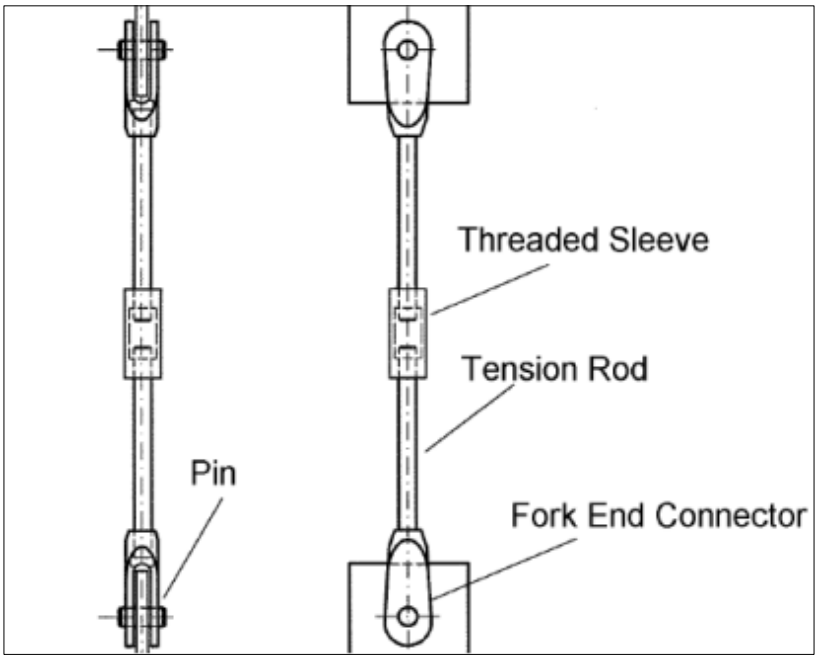


Figure 1: Schematic representation of the tension rod system

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

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 tension rod system is intended for the use in structures with predominantly static loads. Furthermore the tension rod system shall only be used in accessible structures in order to facilitate replacement of individual components at any time.

The intended use comprises for instance the suspension of (glazed) roof constructions or vertical glazings as well as bracings and truss structures.

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 tension rod system for the intended use of 25 years when installed in the works provided that the is subject to appropriate installation, use and maintenance, see Clause 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[1].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body 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] 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.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 1 to 2 show how the performance of the two different product types of the tension rod system is established in relation to the essential characteristics.

Table 1: Essential characteristics of the tension rod system comprised of fork end connector, tension rod, hexagon regular nut and threaded sleeves and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Expression of product performance (Level, class or description)
Basic Works Requirement 1: Mechanical resistance and stability			
Fork end connector			
1	Geometry	2.2.1.1	Description
2	Dimensions		Description
3	Thread		Description
4	Material		Description
5	Load bearing capacity		Level
6	Resistance to corrosion	2.2.1.5	Description
Tension rod			
7	Nominal rod diameter	2.2.1.2	Description
8	Thread		Description
9	Yield strength		Level
10	Tensile strength		Level
11	Material		Description
12	Tension resistance		Level
13	Resistance to corrosion	2.2.1.5	Description
Hexagon regular nut			
14	Geometry	2.2.1.3	Description
15	Dimensions		Description
16	Thread		Description
17	Material		Description
18	Resistance to corrosion	2.2.1.5	Description
Threaded sleeves			
19	Geometry	2.2.1.4	Description
20	Dimensions		Description
21	Thread		Description

No	Essential characteristic	Assessment method	Expression of product performance (Level, class or description)
22	Material	2.2.1.4	Description
23	Load bearing capacity		Level
24	Resistance to corrosion	2.2.1.5	Description
Basic Works Requirement 2: Safety in case of fire			
25	Reaction to fire	2.2.1.6	Class
Basic Works Requirement 4: Safety and accessibility in use			
26	Same as BWR 1		

Table 2: Essential characteristics of the tension rod system comprised of tension rod, hexagon regular nut and threaded sleeves and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Expression of product performance (Level, class or description)
Basic Works Requirement 1: Mechanical resistance and stability			
Tension rod			
1	Nominal rod diameter	2.2.2.1	Description
2	Thread		Description
3	Yield strength		Level
4	Tensile strength		Level
5	Material		Description
6	Tension resistance		Level
7	Resistance to corrosion	2.2.2.4	Description
Hexagon regular nut			
8	Geometry	2.2.2.2	Description
9	Dimensions		Description
10	Thread		Description
11	Material		Description
12	Resistance to corrosion	2.2.2.4	Description

No	Essential characteristic	Assessment method	Expression of product performance (Level, class or description)
Threaded sleeves			
13	Geometry	2.2.2.3	Description
14	Dimensions		Description
15	Thread		Description
16	Material		Description
17	Load bearing capacity		Level
18	Resistance to corrosion	2.2.2.4	Description
Basic Works Requirement 2: Safety in case of fire			
19	Reaction to fire	2.2.2.5	Class
Basic Works Requirement 4: Safety and accessibility in use			
21	Same as BWR 1		

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

Characterisation of products to be assessed shall be done in accordance with available specifications, notably EN 1993-1-1 or EN 1993-1-4. If the material properties of the components of the tension rod system do not correspond to EN 1993-1-1 or EN 1993-1-4 testing of the most important product characteristic the tension resistance shall be carried out. Otherwise tension resistance of the components can be determined without testing by calculation.

The component having the smallest tension resistance is decisive for the value of the tension resistance of the tension rod system.

2.2.1 Tension rod system comprised of fork end connector, tension rod, hexagon regular nut and threaded sleeves

2.2.1.1 Tension resistance of the fork end connector

The characteristic values of the tension resistance of fork end connectors shall be determined by tension tests. The characteristic values of the tension resistance of the fork end connectors shall be determined by tension tests if the conditions given in EN 1993 1 8, chapter 3.13 are not satisfied.

2.2.1.1.1 System sizes to be tested

If the geometrical dimensions of the tension rod system are designed such that the calculated tension resistances of the fork end connectors of all system sizes show a linear correlation to the cross section of the corresponding tension rods then it is sufficient to carry out tension tests only on some of the system sizes. In this case at least four sizes should be tested, namely one small one and two medium sizes as well as the largest size. The linear correlation specified above shall be verified by tests.

If the linear correlation specified above does not exist, at least four system sizes should be tested, to be precise in addition to the largest size three further sizes which have the most unfavourable ratio of calculated tension rod resistance and calculated resistance of the component to be tested both determined according to EN 1993-1-1.

2.2.1.1.2 Determination of the characteristic values of the tension resistance of fork end connectors

The tension tests described in the following are used for the determination of the characteristic values of the tension resistance of fork end connectors as well as for checking the adequate engagement depth.

Within the context of the tests at least three tension tests shall be carried out for each of the system sizes which shall be tested according to Clause 2.2.1.1.1. High-strength tension rods shall be used for the tests in order to force the failure of the fork end connectors (incl. original pins). The engagement depth of the

high strength tension rods shall correspond to the intended engagement depth. The test load shall be increased deformation-controlled until failure of the fork end connectors or pins. The load-deformation curves and the respective failure modes as well as the material properties (yield strength, tensile strength, impact energy at -20°C and elongation), dimensions and geometry of the building components used for the tests (tension rod, fork end connector, pin) shall be documented in the test report. The material properties of the initial material of the building components used for the tests shall be determined by the manufacturer by tests according to EN ISO 6892-1. The test results shall be documented by means of inspection certificates "3.1" according to EN 10204. The results have to correspond to the material specifications given by the manufacturer.

An example for the test setup is shown in Annex 1.

The test results (failure loads) shall be multiplied by a correction factor which takes account of the ratio of nominal tensile/yield strength[2] and the tensile/yield strength of the building components used in the tests. The corrected test results shall be evaluated statistically (determination of 5 % fractiles, confidence level of 75 %).The k_n value for the statistically evaluation shall be taken form EN 1990, Table D.1. Generally a normal distribution can be assumed. The corrected and statistically evaluated test results (5 % fractiles) are the characteristic values $F_{t,Rk}$ of the tension resistance of the system sizes tested.

If at least four system sizes were tested and a linear correlation of the cross section of the tension rods and the tension resistance of the fork end connectors was verified (cf. Clause 2.2.1.1.1), the characteristic values $F_{t,Rk}$ of the system sizes which were not tested shall be determined by interpolation of the characteristic values $F_{t,Rk}$ determined by tests.

If at least four system sizes were tested and no linear correlation of the cross section of the tension rods and the tension resistance of the fork end connectors was verified, the characteristic values $F_{t,Rk}$ of the untested system sizes shall be determined on the safe side as follows:

1. The smallest values min α_1 and min α_2 of the ratios

$$\alpha_1 = F_{t,Rk} / F_{t,Rk1,\text{Tension Rod}}$$

and

$$\alpha_2 = F_{t,Rk} / F_{t,Rk2,\text{Tension Rod}}$$

are determined for the tested system sizes. The corresponding tension rod is used as basis for the determination of the characteristic resistances $F_{t,Rk1,\text{Tension Rod}}$ and $F_{t,Rk2,\text{Tension Rod}}$. The calculation follows Clause 2.2.1.2.2.

2. The characteristic value $F_{t,Rk}$ of the untested system sizes is

$$F_{t,Rk} = \min \{\min \alpha_1 \cdot F_{t,Rk1,\text{Tension Rod}}; \min \alpha_2 \cdot F_{t,Rk2,\text{Tension Rod}}\}$$

The corresponding tension rod is used as basis for the determination of the characteristic resistances $F_{t,Rk1,\text{Tension Rod}}$ and $F_{t,Rk2,\text{Tension Rod}}$. The calculation follows Clause 2.2.1.2.2.

2.2.1.2 Tension resistance of the tension rod

The characteristic values of the tension resistance of tension rods shall be determined by tension tests if the material properties do not correspond to the conditions given in EN 1993-1-1 or EN 1993-1-4. Otherwise tension resistance can be determined without testing by calculation.

2.2.1.2.1 System sizes to be tested

It is sufficient to carry out tension tests only on some of the system sizes. At least four sizes should be tested, namely one small one and two medium sizes as well as the largest size.

2.2.1.2.2 Determination of the characteristic values of the tension resistance of tension rods

The tension tests described in the following are used for the determination of characteristic values of the tension resistance of tension rods.

Within the context of the tests at least three tension tests shall be carried out for each of the system sizes which shall be tested according to Clause 2.2.1.1.1. High-strength fork end connectors or hexagon regular

[2] The ratio resulting in a smaller correction factor is relevant. If fracture occurs as a failure mode the tensile strength shall be used in order to determine the correction factor.

nuts shall be used for the tests in order to force the failure of the tension rods. If relevant the tension rods can be connected to each other by threaded sleeves of a corresponding higher strength than the rods. After rolling the thread on the tension rod it shall be ensured that the remaining peeled section of the tension rod is long enough to determine the 0.2 % yield strength as well as the ultimate elongation in this section during testing.

The test load shall be increased deformation-controlled until failure of the tension rods occurs. The load-deformation curves and the failure modes as well as the material properties (yield strength, tensile strength and elongation), dimensions and geometry of the building components used for the tests (tension rod, fork end connector or hexagon regular nut, pin and if relevant the sleeve) shall be documented in the test report. The material properties of the initial material of the building components used for the tests shall be determined by the manufacturer by tests according to EN ISO 6892-1.

The test results shall be documented by means of inspection certificates "3.1" according to EN 10204. The results have to correspond to the material specifications given by the manufacturer.

For the determination and evaluation of the characteristic values the rules given in Clause 2.2.1.1.2 shall apply accordingly.

In case the material properties of the tension rods correspond to EN 1993-1-1 or EN 1993-1-4 the tension resistance shall be calculated as follows:

$$F_{t,Rk1,Tension\ Rod} = A_{Tension\ Rod} \cdot f_{y,Tension\ Rod}$$

$$F_{t,Rk2,Tension\ Rod} = A_{S,Tension\ Rod} \cdot f_{u,Tension\ Rod}$$

Where

$A_{Tension\ Rod}$ ..... shank cross section of the tension rod

$f_{y,Tension\ Rod}$ ..... characteristic value of the yield strength of the tension rod material

$F_{t,Rk1,Tension\ Rod}$ ..... characteristic tension resistance of the shank cross section $A_{Tension\ Rod}$ of the tension rod

$A_{S,Tension\ Rod}$ ..... threaded cross section of the tension rod

$f_{u,Tension\ Rod}$ ..... characteristic value of the tensile strength of the tension rod material

$F_{t,Rk2,Tension\ Rod}$ ..... characteristic tension resistance of the threaded cross section of the tension rod

2.2.1.3 Tension resistance of the hexagon regular nut

Geometry, dimension, thread and material as well as the strength class of the used hexagon regular nut shall correspond to EN ISO 4032 and EN ISO 898-2.

The conformity of the hexagon regular nuts to EN ISO 4032 and EN ISO 898-2 shall be declared by the manufacturer in form of inspection certificates. The strength class of the hexagon regular nut shall be appropriate for the tension rod concerning tension resistance.

2.2.1.4 Tension resistance of the threaded sleeves

The characteristic values of the tension resistance of threaded sleeves shall be determined by tension tests if the material properties do not correspond to the conditions given in EN 1993-1-1 or EN 1993-1-4. Otherwise tension resistance can be determined without testing by calculation according to EN 1993-1-1.

Type and extent of the test procedure as well as the rules for the determination of characteristic values given in Clause 2.2.1.1 also apply to tests on threaded sleeves. If necessary the threaded sleeves can be tested in combination with the tests on fork end connectors by connecting two high-strength tension rods to each other by one threaded sleeve.

An example for the test setup is shown in Annex 2.

2.2.1.5 Resistance to corrosion

The corrosion protection of components which are not made of corrosion-resistant steel shall be carried out according to EN 1993-1-1 and EN ISO 12944. For stainless steel components the rules given in EN 1993-1-4 shall apply to the material selection and to the manufacture of corrosion-resistant structures. Further references for a corrosion-resistant execution are given in EN 1090-2.

2.2.1.6 Reaction to fire

The components of the tension rod system are considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire in accordance with the EC Decision 96/603/EC[3], as amended, 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.

Therefore the performance of the product is A1.

2.2.2 Tension rod system comprised of tension rod, hexagon regular nut and threaded sleeves

2.2.2.1 Tension resistance of the tension rod

See Clause 2.2.1.2

2.2.2.2 Tension resistance of the hexagon regular nut

See Clause 2.2.1.3

2.2.2.3 Tension resistance of the threaded sleeves

See Clause 2.2.1.4

2.2.2.4 Resistance to corrosion

See Clause 2.2.1.5

2.2.2.5 Reaction to fire

See Clause 2.2.1.6

[3] Official Journal of the European Communities № L 267, 19.10.1996

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

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

For the products covered by this EAD the applicable European legal act is: Decision 1998/214/EC[4], amended by 2001/596/EC[5].

The system is: **2+**

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the tension rod system in the procedure of assessment and verification of constancy of performance are laid down in Table 6.

Table 6: 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	Check of material properties of components	Check if material properties stated in the ETA correspond to the material properties stated in the inspection certificate “type 3.1”	Inspection certificate “type 3.1” according to EN 10204 (to be furnished by supplier of components) 100% compliance to material properties stated in ETA	Every component	Every production unit
2	Check of external and internal quality of cast components	Check if properties of the cast material stated in the ETA correspond to the material properties stated in the annex to inspection certificate “type 3.1”	Annex to inspection certificate “type 3.1” according to EN 10204 (to be furnished by supplier of components) 100% compliance to material properties stated in ETA	Every cast component	Every production unit
3	Check of dimensions of components	Check of dimensions stated in the ETA	–	Every component	Every production unit

[4] Official Journal of the European Communities/Union L 80, 18 3.1998
[5] Official Journal of the European Communities/Union L 209, 2 8.2001

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the procedure of assessment and verification of constancy of performance for the tension rod system are laid down in Table 7.

Table 7: Control plan for the notified body; cornerstones

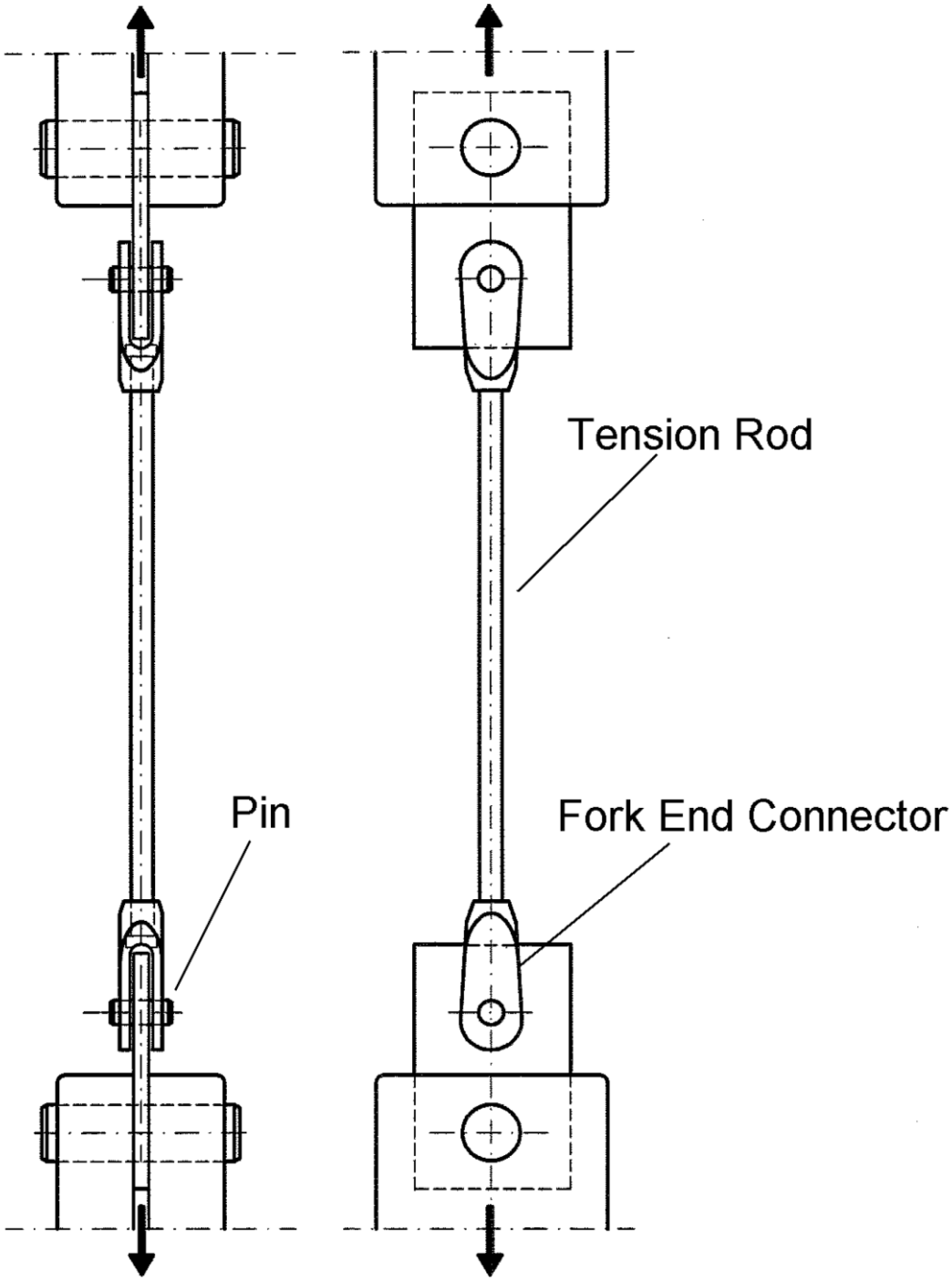
No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control *(for system 2+)*					
2	It shall be ascertained that, in accordance with the test plan, the manufacturing plant of the single product manufacturer, in particular personnel and equipment, and the factory production control are suitable to ensure a continuous and orderly manufacturing of the tension rod system according the European Technical Assessment.				–
Continuous surveillance, assessment and evaluation of factory production control *(for system 2+)*					
3	It shall be verified that the system of factory production control and the specified manufacturing process are maintained taking account of the test plan.				1/year

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment, is of relevance.

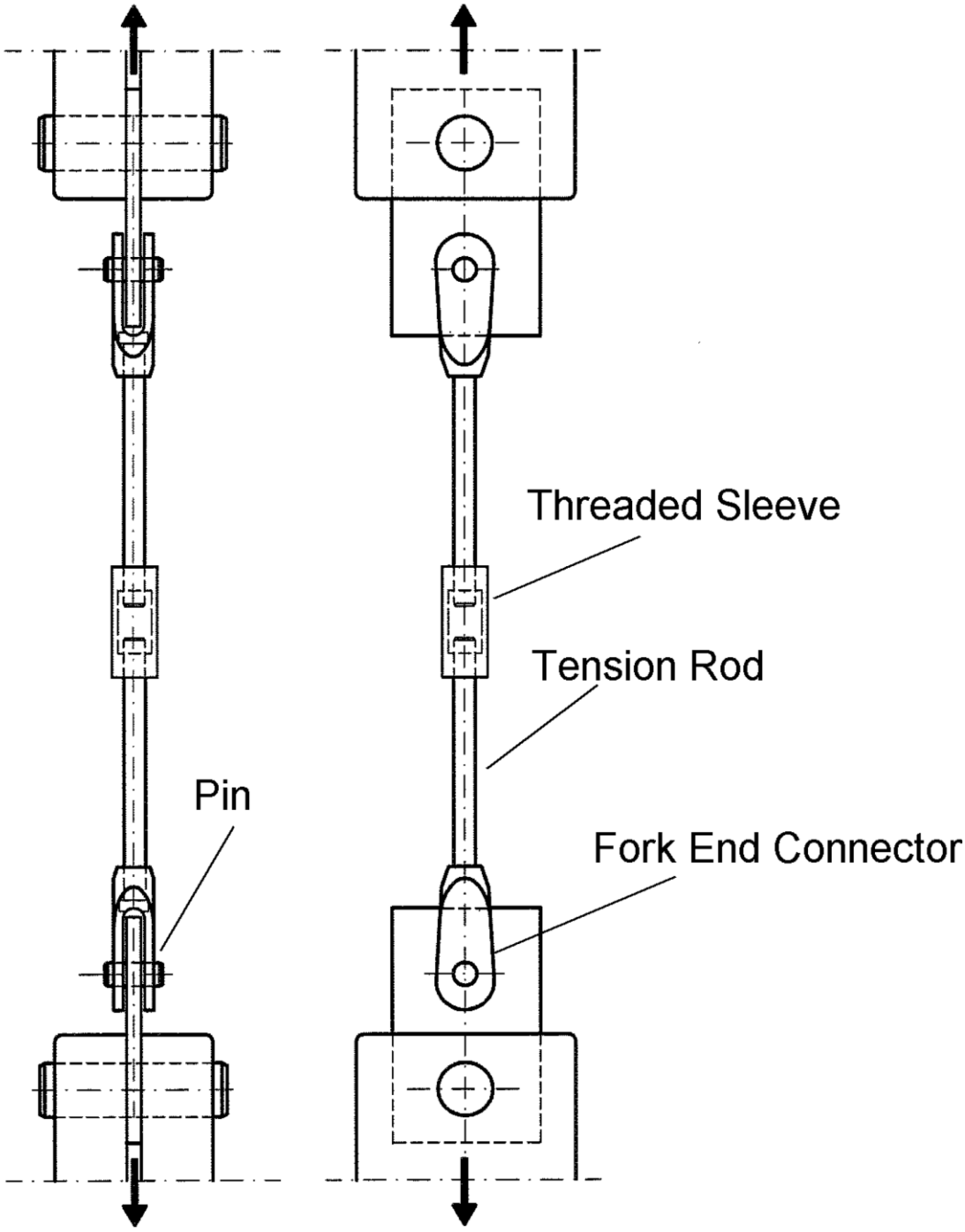
EN 1990 (2002-04 + AC (2008-12) + AC (2010-04)	Eurocode - Basis of structural design
EN 1993-1-1 (2005-05) + AC (2006-02) + AC (2009-04)	Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings
EN 1993-1-4 (2006-10)	Eurocode 3 - Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels
EN 1090-2 (2008-08)	Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures
EN 10204 (2004-10)	Metallic products - Types of inspection documents
EN 13501-1 (2009-09)	Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests
EN 13501-2 (2009-09)	Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance tests, excluding ventilation services
EN ISO 148-1 (2010-10)	Metallic materials - Charpy pendulum impact test - Part 1: Test method
EN ISO 898-2 (2012-03)	Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread
EN ISO 4032 (2012-12)	Hexagon regular nuts (style 1) - Product grades A and B
EN ISO 6892-1 (2009-08)	Metallic materials - Tensile testing - Part 1: Method of test at room temperature
EN ISO 12944-1 (05.1998)	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 1: General introduction
EN ISO 12944-2 (05.1998)	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 2: Classification of environments
EN ISO 12944-3 (05.1998)	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 3: Design consideration
EN ISO 12944-4 (05.1998)	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 4: Types of surface and surface preparation
EN ISO 12944-5 (09.2007)	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 5: Protective paint systems
EN ISO 12944-7 (05.1998)	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 7: Execution and supervision of paint work
EN ISO 12944-8 (05.1998)	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 8: Development of specifications for new work and maintenance

ANNEX 1 – TEST SETUP FOR TENSION TESTS ON FORK END CONNECTORS



Tension rod system	Annex 1
Test setup for tension tests on fork end connectors	of the European Assessment Document EAD 200002-00-0602

ANNEX 2 – TEST SETUP FOR TENSION TESTS ON THREADED SLEEVES



Tension rod system	Annex 2
Test setup for tension tests on threaded sleeves	of the European Assessment Document EAD 200002-00-0602