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MULTI-AXIS CONCEALED HINGE ASSEMBLIES

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1 SCOPE OF THE EAD

1.1 Description of the construction product

The product is a three part hinge, one part a door frame mounting body, one part a door mounting body, one part a connecting device linking the mounting bodies together in such a way as to allow the door to swing freely and to maintain the instantaneous axis of rotation of the leaf perpendicular to a horizontal plane during the full operational cycle between the closed and the open condition of the door, the mounting bodies and the related connecting device providing a variable geometry within a multi-axis concealed hinge assembly.

The product is predominantly made of steel, stainless steel, aluminium or zamac.

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 hinges are intended for use on fire resisting and/or smoke control doors and/or doors on escape routes. They are for use on doors or access windows of timber, metal or synthetic materials. They are invisible (concealed) hinges to allow a single swing door leaf to be mounted to its frame.

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 multi-axis hinge assembly for the intended use of 10 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 works¹.

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 shows how the performance of the multi-axis hinge assembly is assessed in relation to the essential characteristics.

Table 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 2: Safety in case of fire			
1	Reaction to fire	2.2.1	Class
2	Resistance to fire	2.2.2	Grade
Basic Works Requirement 4: Safety and accessibility in use			
4	Permanent function	2.2.3	Number of cycles
5	Friction torque	2.2.3.1	Maximum admissible value
6	Load deformation	2.2.3.2	Test door mass + 100 %
7	Overload	2.2.3.2	Test door mass + 200 %
8	Safety	2.2.4	Grade
9	Corrosion resistance	2.2.5	Grade

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

2.2.1 Reaction to fire

The performance of the multi-axis hinge assembly with respect to the characteristic reaction to fire is to be assessed by the TAB considering the amount of combustible materials and, thus, the fact that a classification of the product might be possible, in accordance with the provisions of EC Decision 96/603/EC 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.

The multi-axis concealed hinge assembly shall be classified according to EN 13501-1.

2.2.2 Resistance to fire

The part of the works or assembled system in which the multi-axis concealed hinge assembly is intended to be incorporated, installed or applied shall be tested, using the test method relevant for the corresponding fire resistance class, in order to be classified according to EN 13501-2. They shall be tested on fire resisting doors according to EN 1634-1.

The multi-axis concealed hinge assembly shall be classified as suitable for fire door use, subject to having been included in a successful fire test to EN 1634-1. The manufacturer will indicate the suitability of the hinge for use on fire doors classified according to EN 13501-2.

The grades of suitability for use on fire/smoke compartmentation doors are identified for multi-axis hinge assemblies are identified according to EN 1935.

2.2.3 Permanent function

The permanent function of the hinges shall be tested and classified in accordance with EN 1935.

Due to the variable geometry of the hinges - two hinges are used for testing.

The test apparatus shall be capable of supporting a hinged test element weighing 480 kg, under which load the vertical axis between the two hinges shall not alter by more than 1 mm from the unloaded position. The apparatus shall be constructed from materials that are not significantly affected by changes in the atmospheric conditions.

The distance between the centres of the two hinges shall be $1540 \text{ mm} \pm 5 \text{ mm}$.

The centre of gravity of the hinged test element shall be $463 \text{ mm} \pm 10 \text{ mm}$ from the vertical axis of rotation and $770 \text{ mm} \pm 5 \text{ mm}$ below the centre of the top test hinge.

The test apparatus shall be capable of cycling the hinged element smoothly through the lesser of $92.5^\circ \pm 2.5^\circ$ or the full angular movement permitted by the hinges at a rate of between 300 and 600 cycles per hour. The opening and closing forces shall be applied without shock at 90° to the hinged test element $425 \text{ mm} \pm 10 \text{ mm}$ below the top test hinge centre and at least 400 mm from the vertical axis of rotation.

The test apparatus shall provide suitable metal mounting plates.

The two test hinges (top hinge and bottom hinge) shall be mounted in positions 1 and 5 of the test apparatus, as detailed in Annex H of EN 1935.

The hinges shall be mounted according to the manufacturer's instructions.

If the manufacturer supplies or specifies the type of fastenings to be used with the hinges, the hinges under test shall be fixed to the test apparatus with such fastenings, unless the supplied fastenings are not suitable for fixing to the testing apparatus (e.g. woodscrews). In this case or when the hinge manufacturer does not supply or specify the type of fastening to be used with the hinges, and if the hinges under test have fixing holes, these shall be used to fasten the hinges to the test apparatus by means of well-fitting machine screws that pass through the holes and have a head shape matched to the contour of the holes.

Fixing points on both test door and frame must be set according to manufacturer instructions. Tighten the mounting screws to the torque recommended by the manufacturer.

Hinges designed to be fixed with auxiliary fixtures shall be fixed by the method specified by the manufacturer.

Hinges that cannot be fastened directly to the test apparatus shall be rigidly fastened first to auxiliary fixtures that match as closely as possible the intended profile shape of the door using the methods specified by the manufacturer for fitting the hinges, such as bolts, clamps or welding. These auxiliary fixtures shall include suitable mortises if they are essential to the proper functioning of the hinge under test. The auxiliary fixtures shall then be rigidly fixed to the mounting plates provided on the test apparatus.

For all fastenings a minimum torque of $5 \text{ Nm} \pm 0,1 \text{ Nm}$ (or as specified by the hinge manufacturer) shall be applied.

2.2.3.1 Friction torque

The hinges shall be tested and classified in accordance with EN 1935.

Due to the variable geometry of the hinges - two hinges are used for testing.

2.2.3.2 Load deformation and Overload

The hinges shall be tested and classified in accordance with EN 1935.

Due to the variable geometry of the hinges - two hinges are used for testing.

2.2.3.2.1 Load deformation

Mount the two test hinges (top and bottom hinge) on the test apparatus (in positions 1 and 5 as detailed in Annex H of EN 1935).

Load the test door (6) so that the total mass is equal to the test door mass as specified in Table 1 of EN 1935 for the grade of hinge under test. Measure the initial horizontal and vertical gaps at the datum points.

Load the door without shock to a total mass equal to the load deformation mass as specified in Table 2 of EN 1935 ensuring that the centre of gravity is maintained at 463 mm from the hinge.

Rotate the door through an angle of $92,5^\circ \pm 2,5^\circ$, (or maximum angle permitted by the hinge if less than 90°) 20 times. Measure the horizontal and vertical gaps at the datum points.

Remove the additional load without shock, allow a period of 1 to 2 minutes then measure the horizontal and vertical gaps at the datum points.

Examine the hinge for cracks, breakage or deformation of any component. Verify that requirements are met:

- a) The lateral displacement under load shall not exceed 2 mm.
- b) The vertical displacement under load shall not exceed 4 mm.
- c) The lateral and vertical displacements after unloading shall be within the shaded area of Figure G.1 in Annex G of EN 1935.
- d) There shall be neither breakage of any component nor any cracking visible to normal or corrected vision.

2.2.3.2.2 Overload

After completion of tests (load deformation), apply without shock the two loads equal to the overload mass specified in Table 2 of EN 1935 at the centre of gravity at the position specified in Figure H.2 in Annex H of EN 1935

Rotate the element through an angle of $90^\circ \pm 2,5^\circ$ (or maximum angle permitted by the hinge if less than 90°) five times. Sustain the load for a period of 1 to 2 minutes and then remove.

Examine the hinge for cracks, breakage or deformation of any component. Verify that requirements are met:

- a) There shall be no breakage of any hinge mounting plate, linkage or pin no any cracking or deformation visible to normal or corrected vision.
- b) The hinged test element shall remain connected to the frame even though the hinge may have been rendered inoperable.

2.2.3.2.3 Initial measurements and Durability

Due to the variable geometry of the hinges - two hinges are used for testing.

Mount the two test hinges (top and bottom hinge) on the test apparatus (in positions 1 and 5 as detailed in Annex H of EN 1935).

Load the test door (6) to the test door mass as specified in Table 1 of EN 1935 for the grade of hinge under test.

Rotate the door through an angle of $92,5^\circ \pm 2,5^\circ$, or maximum angle permitted by the hinge if less than 90° , 20 times.

Measure torque to initiate movement of the hinged element at angles of $0 \pm 5^\circ$, $30 \pm 5^\circ$, $60 \pm 5^\circ$ and $90 \pm 5^\circ$. Measure the initial horizontal and vertical gaps at the datum points.

Rotate the door through an angle of $92,5^\circ \pm 2,5^\circ$, or maximum angle permitted by the hinge if less than 90° for the number of cycles specified as number of test cycles in Table 1 of EN 1935 for the grade of hinge under test.

Ensure that the hinge is fully closed at the end of each cycle.

The speed of operation shall be 300 ± 30 to 600 ± 30 cycles per hour.

For all tests lubricate the hinge according to manufacturer's instructions before commencing cycling and then after every $5,000 \pm 300$ cycles up to and including $20,000 \pm 300$ cycles or $175,000 \pm 300$ cycles.

After the required number of cycles specified as number of test cycles in Table 1 of EN 1935 for the grade of hinge under test, without further lubrication repeat the measurements of frictional torque and horizontal and vertical gaps.

Verify that the requirements are met:

- the amount of lateral and vertical wear of the hinges under test, measured as displacements from the datum surface, shall be within the shaded area of Figure G.2 of Annex G of EN 1935;
- the maximum admissible friction torque after the first 20 cycles and also after the requested number of cycles is as specified in clause 5.4 of EN 1935 for the grade of hinge under test.

Before removing the samples, subject them to an overload test as specified in clause 2.2.3.2.2. Verify that the requirements of clause 2.2.3.2.2 are met.

2.2.4 Safety

The hinges safety - the essential requirement of safety in use - shall be classified in accordance with clause 4.6 of EN 1935.

2.2.5 Corrosion resistance

The hinges shall be tested and classified in accordance with EN 1935.

2.2.6 Category of use

Categories of use are identified according to EN 1935.

2.2.7 Test door mass

The mass of test doors were specified according to EN 1935.

2.2.8 Security

The hinge grades are identified according to clause 4.8 of EN 1935.

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: Decision 1999/93/EC.

The system is: 1

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the multi-axis concealed hinge assembly in the procedure of assessment and verification of constancy of performance are laid down in Table 2.

Table 2 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	Identification of the incoming materials - precise designation of the material - if possible references to European and/or international standards or relevant specifications	visual examination and size check	compliance with required materials	1-2	every delivery
2	Checking of compliance of actual dimensions with specified dimensions (drawings)		compliance with required tolerances	1	- at the beginning of a production series - at large production series → every day of production - at small series and single-unit production → every 30 th product
3	Checking that all relevant sub-assemblies (including any that are outsourced) meet an appropriate operational performance at the manufacturing stage		compliance with requirements of EN 1935	1-2	each product
4	Checking the operation of the mechanism and the marking	visual examination		each product	
5	Checking the concealed hinge assembly in accordance with EN 1935		EN 1935	2 of a family or a series	once a year

The manufacturer of the multi-axis concealed hinge assembly covered by this EAD shall document, operate and maintain an adequate factory production control system to enable the achievement of the required product characteristics and the effective operation of the production control system to be checked.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control, which he applies. The manufacturer's documentation and procedures shall be appropriate to the product and manufacturing process.

The manufacturer shall treat non-conforming products as follows:

- isolate and identify non-conforming products;
- undertake the necessary corrective actions;
- repeat tests as appropriate to prove that product meets the specifications.

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 multi-axis concealed hinge assembly are laid down in Table 3.

Table 3 Control plan for the notified body; cornerstones

No	Subject/type of control (product, raw/constituent material, component - indicating characteristic concerned)	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	Inspection of factory and factory production control as described in the control plan of the ETA Making families of hinges with common design features - there is no need to test each individual hinge, as results may be based upon those from a test carried out on a hinge representative of the type.	control of devices, equipment and documentation of the FPC	compliance with requirements of EN 1935	5	when starting the production or a new product line
Continuous surveillance, assessment and evaluation of factory production control					
2	Identification of the incoming materials - precise designation of the material - if possible references to European and/or international standards or relevant specifications	visual examination and size check	compliance with required materials	5	twice a year
	Checking of compliance of actual dimensions with specified dimensions (drawings)		compliance with required tolerances	5	twice a year
	Checking that all relevant sub-assemblies (including any that are outsourced) meet an appropriate operational performance at the manufacturing stage		compliance with requirements of EN 1935	5	twice a year
	Checking the operation of the mechanism and the marking	visual examination		5	once a year
	Checking the concealed hinge assembly in accordance with EN 1935		EN 1935	5	once a year

3.4 Special methods of control and testing used for the assessment and verification of constancy of performance

Samples representing the series shall be subjected to the full test sequence of clause 2.

For the purpose of a European Technical Assessment based on this EAD, the selection of test samples shall physically be made as follows:

- separate tests shall be conducted where devices have different numbers of linkages,
- separate tests shall be conducted where significant components (which can affect its performance to the standard) are of different design or material,
- all minor variations of model shall be tested,
- Prototype samples are acceptable, if made from production tooling and using production assembly equipment.

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 1935:2002-05	Building hardware - single axis hinges - Requirements and test methods
EN 1634-1	Fire resistance and smoke control tests for door, shutter and openable window assemblies and elements of building hardware - Part 1: Fire resistance tests for doors, shutters and openable windows
EN 1634-3	Fire resistance tests for door and shutter assemblies - Part 3: Smoke control doors and shutters
EN 13501-1	Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests
EN 13501-2	Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance tests, excluding ventilation services