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European Assessment Document for

Structural hollow sections of weathering steel

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Contents

1 SCOPE OF THE EAD

1.1 Description of the construction product

This EAD covers structural hollow sections made of structural steel with improved atmospheric corrosion resistance, hereinafter referred to as “hollow sections of weathering steel”.

Hollow sections of weathering steel are not fully covered by the following harmonised technical specification: EN 10210-1[1]. EN 10210-1 covers structural hollow sections of non-alloy and fine grain steels but the chemical compositions of those steels differ from the compositions of hollow sections of weathering steel. The grade designations are specific to hollow sections of weathering steel and are not contained in EN 10210-1. The methods of assessment, essential characteristics (other than the chemical composition) and factory production control measures in EN 10210-1 apply to the product, subject to the minor updates and clarifications of EN 10210-3.

The essential characteristic “reaction to fire” has been added to this EAD.

Hollow sections of weathering steel are covered by EN 10210-3, which is not a harmonised standard and also covers other products. Table E.1 of EN 10210-3 specifies that the weathering steels must contain minimum amounts of chromium (Cr), copper (Cu) and at least one of aluminium (Al), niobium (Nb), vanadium (V) and titanium (Ti). This composition distinguishes weathering steels from steels covered by EN 10210-1.

Hollow sections of weathering steel contain no organic material.

The names for hollow sections of weathering steel are allocated in accordance with EN 10027-1. This EAD covers hollow sections of the following grades as defined in Annex E of EN 10210-3:

- S355J0WH,
- S355J2WH,
- S355K2WH,
- S420K2WH,
- S460K2WH,
- S500K2WH.

The use of these grade designations in Table E.3 of EN 10210-3 implies that the grades referred to by this EAD are associated with a set of threshold values for yield strength R_{eH}, tensile strength R_m, elongation after fracture A and impact energy KV_2. These values are established in the harmonised standard EN 10025-1 by reference to EN 10025-5 for grades of hot rolled products with improved atmospheric corrosion resistance that are equivalent to the grades referred to by this EAD. Products with performance outside Table E.3 of EN 10210-3 are not covered by this EAD.

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

The meaning of the grade designations for weathering steel is given in Clause 4.2.2 of EN 10210-3. The chemical composition of the weathering steel shall be in accordance with the composition for the specified grade given in Table E.1 of EN 10210-3. Any deviations in the chemical composition of the weathering steel shall be within the limits given in Table 1 of EN 10210-3.

A range of shapes and sizes of structural hollow sections is given in Clause 1 of EN 10210-2. Dimensional tolerances for these sections are given in Clause 6 of EN 10210-2. For consistency, the scope of this EAD is limited to a range of hollow sections of weathering steel of the same shapes, sizes and dimensional tolerances as EN 10210-2.

Following Clause 1 (Scope) of EN 10210-3 the products are weather resistant hot finished seamless, electric welded or submerged arc welded steel structural hollow sections of circular, square, rectangular or elliptical form.[2]

Weathering steel products are manufactured from high strength low alloy steel grades that, under normal atmospheric conditions, give an enhanced resistance to rusting. All low alloy steels tend to rust in the presence of moisture and air, whereby the rate of rusting depends on the access of oxygen, moisture and atmospheric contaminants to the metal surface. As rusting progresses, the rust layer forms a barrier to the ingress of oxygen, moisture and contaminants, and the rate of rusting slows down.

The rust layers formed on structural steels without an enhanced resistance are porous and detach from the metal surface after a certain time, and the corrosion cycle commences again. Consequently, the rusting rate progresses as a series of incremental curves approximating to a straight line, the slope of which depends on the aggressiveness of the environment.

With weathering steel, the rusting process is initiated in the same way, but the specific alloying elements in the steel produce a stable rust layer that adheres to the base metal and is much less porous than the layers on steel without an enhanced resistance. This rust ‘patina’ develops under conditions of alternate wetting and drying to produce a protective barrier that impedes further access of oxygen, moisture and pollutants. The result is a lower corrosion rate than for ordinary structural steel. The degree of protection afforded depends on the environmental and other conditions prevailing at the site of the structure.

The informative notes in Annex B of EN 10025-5 on the susceptibility to corrosion of steels with improved atmospheric corrosion resistance apply to the hollow sections of weathering steel covered by this EAD.

The informative notes in Annex C.1 of EN 10025-5 on the weldability of steels with improved atmospheric corrosion resistance apply to the hollow sections of weathering steel covered by this EAD.

All weathering steel grades in this EAD are alloy special steels according to the classification system in EN 10020.

The starting feedstock material from the steel producer shall be specified by the hollow section manufacturer in accordance with Table G.1 of EN 10210-3 depending on the hollow section production process.

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 hollow sections of weathering steel 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, e.g., with regard to the intended end use conditions, 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 as long as the details of the assessment methods as laid down in this EAD are respected.

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2 As weather resistant steels are normally used unpainted, it is necessary to select welding consumables which achieve at least equivalent weathering properties to the permanently exposed surfaces.

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

1.2.1 Intended use(s)

Hollow sections of weathering steel are intended to be used in metal structures or in composite metal and concrete structures where improved atmospheric corrosion resistance is needed.

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 hollow sections of weathering steel 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[3].

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

1.3 Specific terms used in this EAD

General definitions for terms associated with structural hollow sections in steel are found in EN 10266. Definitions of terms associated with weathering steel are given here.

1.3.1 Hot finished

Hollow sections formed hot, with or without subsequent heat treatment, or formed cold with subsequent heat treatment above 580 °C to obtain equivalent metallurgical conditions to those obtained in the hot formed product (Clause 3.1.1 of EN 10210-3).

1.3.2 Weathering steel

Steel with improved atmospheric corrosion resistance in which a certain number of alloying elements has been added in order to increase its resistance to atmospheric corrosion, by forming an auto-protective oxide layer on the base metal under the influence of weather conditions (Clause 3.1.4 of EN 10210-3).

1.3.3 Symbols

A elongation after fracture. The permanent elongation of the gauge length after fracture, expressed as a percentage of the original gauge length, determined in accordance with EN ISO 6892-1.

KV_2 absorbed energy in Joules required to break a test piece with a pendulum impact testing machine, after correction for friction, in accordance with EN ISO 148-1. The letter V indicates the notch geometry. The subscript 2 is the radius of the striker in mm.

R_{eH} upper yield strength. Maximum value of stress prior to the first decrease in force, determined in accordance with EN ISO 6892-1. Used as the representative value of the yield strength in this EAD.

R_m tensile strength. Stress corresponding to the maximum force, determined in accordance with EN ISO 6892-1.

[3] 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 2.1.1 shows how the performance of hollow sections of weathering steel 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	Tolerances on shape, dimensions and mass	2.2.1	Level (mm or % or angular degree)
2	Yield strength	2.2.2	Level (MPa)
3	Tensile strength	2.2.3	Level (MPa)
4	Elongation	2.2.4	Level (%)
5	Impact energy	2.2.5	Level (J)
Basic Works Requirement 2: Safety in case of fire			
6	Reaction to Fire	2.2.6	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.

The use of Table E.3 of EN 10210-3 implies that the grades referred to by this EAD are associated with a set of threshold values for yield strength R_{eH}, tensile strength R_m, elongation after fracture A and impact energy KV_2. These values are established in the harmonised standard EN 10025-1 by reference to EN 10025-5 for grades of hot rolled products that are equivalent to the grades referred to by this EAD.

2.2.1 Tolerances on shape, dimensions and mass

The size and shape of the hollow section shall be measured in accordance with Clause 7 of EN 10210-2. All measurements applicable to the section geometry shall be carried out. It shall be stated in the ETA whether or not the deviations are within the tolerances given in Table 2, Table 3 and Table 4 of EN 10210-2.

2.2.2 Yield strength

In accordance with Clause 10.2.2 of EN 10210-3 the upper yield strength R_{eH} of the product shall be determined from a tensile test carried out in accordance with EN ISO 6892-1. Method A1, A2 or B of EN ISO 6892-1 may be used, but Method A1 is the reference method.

The other conditions of Clause 10.2.2 of EN 10210-3 apply where they are relevant to the reporting of the yield strength.

Tensile test specimens shall conform to the requirements of Clauses 9.3.1, 9.4.1 and 9.4.2 of EN 10210-3.

In accordance with Clause 10.2.1 of EN 10210-3 tensile tests shall be carried out in the temperature range 10 °C to 35 °C.

In order to describe the hollow section in terms of a steel grade, the upper yield strength R_{eH} determined by test shall be at least equal to the minimum yield strength R_{eH} (in MPa) for the grade given in Table E.3 of EN 10210-3 at the tested thickness.

2.2.3 Tensile strength

In accordance with Clause 10.2.2 of EN 10210-3 the tensile strength R_m of the product shall be determined from a tensile test carried out in accordance with EN ISO 6892-1. Method A1, A2 or B of EN ISO 6892-1 may be used, but Method A1 is the reference method.

Tensile test specimens shall conform to the requirements of Clauses 9.3.1, 9.4.1 and 9.4.2 of EN 10210-3.

In order to describe the hollow section in terms of a steel grade, the tensile strength R_m determined by test shall be at least equal to the minimum tensile strength R_m (in MPa) for the grade given in Table E.3 of EN 10210-3 at the tested thickness.

2.2.4 Elongation

In accordance with Clause 10.2.2 of EN 10210-3 the percentage elongation after fracture A of the product shall be determined in accordance with EN ISO 6892-1.

The other conditions of Clause 10.2.2 of EN 10210-3 apply where they are relevant to the reporting of the percentage elongation after fracture.

Tensile test specimens shall conform to the requirements of Clauses 9.3.1, 9.4.1 and 9.4.2 of EN 10210-3.

In accordance with Clause 10.2.1 of EN 10210-3 tensile tests shall be carried out in the temperature range 10 °C to 35 °C.

In order to describe the hollow section in terms of a steel grade, the elongation after fracture *A* determined by test shall be at least equal to the minimum elongation after fracture *A* (in %) for the grade given in Table E.3 of EN 10210-3 at the tested thickness.

2.2.5 Impact energy

In accordance with EN 10025-1 Clause 7.3.2.1, impact energy tests are not required for products with wall thicknesses < 6,0 mm which are assumed to comply with the grade designation if the grade requirements for yield strength, tensile strength and elongation after fracture are met.

In order to describe the hollow section in terms of a steel grade, the impact energy KV_2 of products with wall thicknesses < 6,0 mm shall be stated as the minimum impact energy KV_2 (in J) given in Table E.3 of EN 10210-3 for the grade if the remaining grade requirements are met.

For thicknesses ≥ 6,0 mm, the impact energy KV_2 in Joules shall be determined from tests in accordance with EN ISO 148-1 and Clause 10.2.3 of EN 10210-3[4].

Impact test specimens shall conform to the requirements of Clauses 9.3.2, 9.4.1 and 9.4.3 of EN 10210-3.

In accordance with Clause 10.2.1 of EN 10210-3 impact tests shall be carried out at the temperatures given in Table E.3 of EN 10210-3 for the specified grade.

In order to describe the hollow section in terms of a steel grade, the impact energy KV_2 determined by test shall be at least equal to the minimum impact energy KV_2 (in J) for the grade given in Table E.3 of EN 10210-3 at the tested thickness.

2.2.6 Reaction to fire

Hollow sections of weathering steel are considered to satisfy the requirements of class A1 of the reaction-to-fire performance in accordance with the Commission Decision 96/603/EC, as amended by Commission Decisions 2000/605/EC and 2003/424/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.

Therefore, when the conditions referred to above are fulfilled, the performance of hollow sections of weathering steel is class A1 which shall be given in the ETA.

4 Note that the requirements a), b) and c) of Clause 10.2.3 of EN 10210-3 are identical to those of Clause 9.2.3 of the harmonised standard EN 10210-1

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 Commission Decision 98/214/EC, as amended by Commission Decision 2001/596/EC.

The system is 2+.

3.2 Tasks of the manufacturer

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

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Cast Analysis	3.4.1	According to control plan	One	per cast
2	Tensile Test	2.2.2	According to control plan	One	per test unit [a]
3	Impact Test	2.2.5 (not for products with thicknesses < 6,0 mm)	According to control plan	One sample sufficient for two sets of three pieces	per test unit [b]
4	Surface Condition	3.4.2	According to control plan	One	per test unit [b]
5	Tolerances on shape, dimensions and mass	2.2.1	According to control plan	One	per test unit [b]
6	Non-destructive testing (NDT) of the weld	3.4.3	According to control plan	All welded products, full length of weld.	All welded products, full length of weld.

a) A test unit is defined in Clause 9.1 of EN 10210-3 as a quantity of hollow sections from one manufacturing lot of same grade and sectional dimensions including hollow sections from one or more coils or bars or ingots originating from one or more casts and, if applicable, in the same heat treatment condition, submitted for acceptance at the same time.

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 hollow sections of weathering steel are laid down in Table 3.3.1.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	Notified Body will ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the hollow sections of weathering steel.	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	According to Control plan	According to Control plan	When starting the production or a new line
Continuing surveillance, assessment and evaluation of factory production control					
2	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	According to Control plan	According to Control plan	1/year

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

3.4.1 Chemical analysis

The manufacturer shall obtain the report of the chemical composition determined by cast analysis from the steel producer. The manufacturer shall verify that the chemical composition complies with the requirements given in Table E.1 of EN 10210-3 and the permissible deviations in Table 1 of EN 10210-3. All the elements given in Table E.1 of EN 10210-3 shall be reported including Al, Nb, V and Ti if present.

The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the steel producer. In case of dispute, the method used shall be the reference method for the element and range of application given in CEN/TR 10261 Annex C.

The manufacturer shall determine the carbon equivalent value (CEV) based on the cast analyses in accordance with Clause 7.1.1 of EN 10210-3. The increase in maximum CEV value given in Clause 7.1.2 of EN 10210-3 is permitted when the conditions given in the clause are fulfilled. The maximum CEV for the specified grade in Table E.2 of EN 10210-3 shall apply.

3.4.2 Visual assessment of surface

In accordance with Clause 7.4.1 of EN 10210-3 the hollow sections of weathering steel shall have a smooth surface corresponding to the manufacturing method used; bumps, cavities or shallow longitudinal grooves resulting from the manufacturing process are permissible, provided the thickness is within the tolerance given in Table 2 of EN 10210-2.

The other conditions of Clause 7.4 of EN 10210-3 apply.

3.4.3 Weld seam imperfections

In accordance with Clause 7.5 of EN 10210-3 non-destructive testing (NDT) for the detection of imperfections in the weld seam shall be performed in the full length of the weld for all welded hollow sections of weathering steel.

For electric welded hollow sections of weathering steel, test methods and their acceptance classes are given in Clause 10.4.2 of EN 10210-3. Repairs to the weld seam are not permitted.

For submerged arc hollow sections of weathering steel, test methods and their acceptance classes are given in Clause 10.4.3 of EN 10210-3. Repairs to the weld seam are permitted.

4 REFERENCE DOCUMENTS

EN 10020:2000	Definition and classification of grades of steel
EN 10021:2006	General technical delivery conditions for steel products
EN 10025-1:2004	Hot rolled products of structural steels - Part 1: General technical delivery conditions
EN 10025-5:2019	Hot rolled products of structural steels - Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
EN 10027-1:2016	Designation systems for steels - Part 1: Steel names
EN 10204:2004	Metallic products - Types of inspection documents
EN 10210-1:2006	Hot finished structural hollow sections of non-alloy and fine grain steels – Part 1: Technical delivery conditions
EN 10210-2:2019	Hot finished steel structural hollow sections - Part 2: Tolerances, dimensions and sectional properties
EN 10210-3:2020	Hot finished steel structural hollow sections - Part 3: Technical delivery conditions for high strength and weather resistant steels
EN 10266:2003	Steel tubes, fittings and structural hollow sections – Symbols and definitions of terms for use in product standards
EN ISO 148-1:2016	Metallic materials - Charpy pendulum impact test - Part 1: Test method (ISO 148-1:2016)
EN ISO 6892-1:2019	Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1:2019)
CEN/TR 10261:2023	Iron and steel - European standards for the determination of chemical composition