SLOVENSKI STANDARD

SIST EN 13674-4:2006

01-oktober-2006

Železniške naprave – Zgornji ustroj – Tirnice – 4. del: Vignolove tirnice z maso v razponu od 27 kg/m do 46 kg/m

Railway applications - Track - Rail - Part 4: Vignole railway rails from 27 kg/m to, but excluding 46 kg/m

Bahnanwendungen - Oberbau - Schienen - Teil 4: Vignolschienen mit einer längenbezogenen Masse zwischen 27 kg/m und unter 46 kg/m

Applications ferroviaires - Voie - Rails - Partie 4: Rails Vignole de masse comprise entre 27 kg/m et 46 kg/m, 46 kg/m non compris

Ta slovenski standard je istoveten z: **EN 13674-4:2006**

ICS:

45.080	Traļ nice in ģelezniģki deli	Rails and railway components

SIST EN 13674-4:2006 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13674-4

April 2006

ICS 45.080

English Version

Railway applications - Track - Rail - Part 4: Vignole railway rails from 27 kg/m to, but excluding 46 kg/m

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Ref. No. EN 13674-4:2006: E

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Foreword

This European Standard (EN 13674-4:2006) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2006, and conflicting national standards shall be withdrawn at the latest by October 2006.

This part of EN 13674 is the fourth of the series EN 13674 *Railway applications – Track – Rail* which consists of the following parts:

— Part 1: Vignole railway rails 46 kg/m and above;

— Part 2: Switch and crossing rails used in conjunction with Vignole railway rails 46 kg/m and above;

— Part 3: Check rails;

— Part 4: Vignole railway rails from 27 kg/m to, but excluding 46 kg/m.

Other standards planned for publication include the following:

— prEN 14587-1 Railway applications– Track – Flash butt welding of rails – Part 1: New R220, R260, R260Mn and R350HT grade rails in a fixed plant;

— prEN 14587-2 Railway applications – Track – Flash butt welding of rails – Part 2: New R220, R260, R260Mn and R350HT grade rails by mobile welding machines at sites other than at a fixed plant;

— prEN 14587-3 Railway applications – Track – Flash butt welding of rails – Part 3: Welding in association with crossing construction;

— prEN 14730-1 Railway applications – Track – Aluminothermic welding of rails – Part 1: Approval of welding processes;

— prEN 14730-2 Railway applications – Track – Aluminothermic welding of rails – Part 2: Qualification of aluminothermic welders, approval of contractors and acceptance of welds;

— prEN 14811 Railway applications – Track – Special purpose rail – Grooved and associated construction;

— prEN xxxxx Railway applications – Track – Restoration of rails by electric arc welding.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This introduction provides an explanation of the concepts and reasoning used in the drafting of this European Standard. Its inclusion also ensures that during future revisions, restrictions are removed where technology progresses and held where it does not, thus ensuring continued safety as new manufacturers, products and technologies are introduced.

The most commonly used standards of the world for the supply of railway rails have been reviewed during the preparation of this European Standard. However, modern rail production technology within the European Union has demanded a completely new look at the philosophy and content of this part of EN 13674.

Whenever possible this part of EN 13674 is performance based, recognises the European Quality System standard EN ISO 9001 and requires manufacturers to offer the latest proven technology to consistently satisfy the demanding quality of the required product.

Rail grading is based on hardness rather than tensile strength.

The acceptance tests have been designed to control those characteristics of the rail steel and rail that are of relevance to the production of high quality rails and the demands of the railway.

The steel grades covered by this part of EN 13674 reflect trends in railway usage and heat treated rails are included. This European Standard includes rail profiles for Vignole rails having a linear mass from 27 kg/m to, but excluding 46 kg/m.

To ensure the supply of high quality rails, some restrictions on production processes have been imposed.

This European Standard supersedes national standards covered by the scope. In addition CEN required, where possible, a performance based standard, taking into account safety implications and at the same time addressing modern production technology. It was recognised that there would be few opportunities (and these would have to be for transparent safety considerations) for derogation from this European Standard to operate between the user and the manufacturer.

This European Standard reflects this change in philosophy from the traditional content of rail standards. A review was undertaken of the most commonly used rail standards of the world. All relevant aspects important to both user and manufacturer were considered with the aim of ensuring that all of the content had specific usefulness and relevance. For example rail grading and much of this European Standard has been based on hardness rather than tensile strength. Whilst the two are directly related, hardness is very quick and cheap to carry out and provides more relevant guidance to the user particularly where properties vary in different parts of the profile.

Since many rail manufacturers would not have previously carried out proving trials, this European Standard includes a prerequisite for all manufacturers to prove conformity against a set of qualifying test criteria at the time of tendering. The qualifying tests include all “normal” acceptance test results plus new ‘type-casting’ features such as fracture toughness, fatigue and residual stress (see EN 13674-1). To provide users with the necessary confidence, acceptance limits have been based on results from rail known to have performed well in demanding track installations.

One aspect of this European Standard, which is a complete break from tradition, is the inclusion of quality assurance and inspection clause as part of product integrity.

In order that quality management systems are consistent across all manufacturers and that users have the best assurance for the consistency of required product quality on this safety critical component of the track, the rail standard requires that the manufacturers quality assurance systems are at least equivalent to the requirements of EN ISO 9001. The inclusion of this requirement also reduces the need to incorporate detailed method and calibration descriptions on items such as normal chemical composition determination and the need to define more extensive testing.

Ideally, manufacturing techniques should not be referenced in a product standard. However, some rail attributes are either not known in an exact manner or are not measurable with satisfactory statistical significance. In such cases best practice manufacturing techniques have been included as a last resort. The equipment specified is that which gives the best probability of achieving the required product for use in track. In the future new technology can add to, but preferably will reduce or delete such items.

Examples of areas where the technological state of the art renders the standard less than complete include:

— oxide/oxygen relationships;

— hydrogen test techniques;

— roller straightening effects on residual stresses;

— roller straightening effects on contact scrub;

— measurement and effect of residual stresses throughout the rail.

1 Scope

This part of EN 13674 specifies flat bottom Vignole railway rails from 27 kg/m to, but excluding 46 kg/m.

Five pearlitic steel grades are specified covering a rail hardness range of 200 HBW to 390 HBW and include non-heat-treated non-alloy steels, non-heat-treated alloy steels and heat-treated non-alloy steels.

There are 13 rail profiles specified in this European Standard, but these may not be available in all steel grades.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

EN 10163-1, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections — Part 1: General requirements*

EN 13674-1:2003, *Railway applications — Track — Rail — Part 1: Vignole railway rails 46 kg/m and above*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
heat
one liquid steel melt tapped out of a converter or electric arc furnace which includes after continuous casting a given number of blooms relating to the weight of the heat and the extension of the mixing zone

NOTE In the case of sequence casting the blooms belonging to the mixing zone should be clearly defined.

3.2
sequence
number of heats, of the same steel grade, which undergo continuous casting in tundishes. Tundishes may be used in parallel if the caster has many strands

3.3
heat treated rail
rail that has undergone accelerated cooling from austenitizing temperature during the metallurgical transformation period

3.4
re-heated rail
all rolled rail that has undergone re-austenitization for heat treatment purposes

3.5
mill heat treated rail
heat treated rail that has not undergone re-austenitization after rolling

3.6
rolling process
process between the blooms leaving the heating furnace and exiting the finishing pass

3.7
isothermal treatment process
process whereby blooms are held for a period of time at an elevated temperature for diminishing the hydrogen content

NOTE 1 For maximum efficiency this is as near to (but below) the pearlite to austenite transformation temperature as is practically possible.

NOTE 2 This process is sometimes referred to as sub critical diffusion annealing.

3.8
qualifying tests
special tests and criteria which are relevant to some aspects of the service performance of rails. Acceptance tests also form part of the qualifying tests

3.9
acceptance tests
tests carried out as part of the process and product control system, normally on a heat, sequence or tonnage basis

4 Information to be supplied by the purchaser

The purchaser shall provide the supplier with the following information when inviting tenders to supply:

a) rail profiles (see Annex A);

b) steel grades (see Table 1);

c) lengths of rail including any rails for special purposes (see Table 8);

d) un-drilled or drilled rail ends to take fish plate bolts and the location and dimensions of holes when required (see 9.2.3);

e) any special treatments to be applied to bolt holes;

f) tolerances for bolt holes to which special processes are to be applied (see 9.2.3);

g) paint code requirements (see 7.4.4);

h) tolerances for the horizontal and vertical straightness of un-drilled rail ends (to be welded).

5 Steel grades

The applicable steel grades are given in Table 1. The hardness ranges of the steel grades shall conform to those given in Table 1.

The steel grade designations referred to in this European Standard, are compared to the corresponding steel designations in EN 10027-1 and EN 10027-2 as shown in Annex B.

Table 1 — Steel grades

Grade [a]	Hardness range (HBW)	Description	Branding lines
R200	200 to 240	Non-alloy (C-Mn)	No branding lines
R220	220 to 260	Non-alloy (C-Mn)	_____
R260	260 to 300	Non-alloy (C-Mn)	___ _____
R320Cr	320 to 360	Alloy (1 % Cr)	_____ _____ _____
R350HT	350 to 390 [b]	Non-alloy (C-Mn), heat treated	____ _____ _____

[a] See Table 3 for chemical composition/mechanical properties.

[b] See Table 5 for hardness requirements.

6 Dimensions, static properties, linear mass and tolerances

Rail profiles, dimensions, static properties and linear masses are given in Annex A. The tolerances of certain dimensions shall be as given in Table 6. All other quantities are informative only.

NOTE Linear masses have been calculated based on the density of steel of 7,85 g/cm^3.

7 Manufacture

7.1 Product integrity

7.1.1 Factory production control

Rails shall be produced under a comprehensive system of factory production control, which shall ensure confidence in the conformity of the finished product. The system shall address this European Standard to ensure that the finished products consistently comply with requirements to achieve the product integrity necessary to provide assurance of product safety in track.

Manufacturers shall demonstrate continuing compliance, including documented evidence, with the factory production control system required.

Manufacturers having a factory production control system, which complies with EN ISO 9001 are recognised as satisfying the minimum requirements specified by this clause.

7.1.2 Best practice manufacture

The product shall be manufactured to the best practices as defined in 7.1.1.

NOTE This is to ensure that the rail attributes, described in the Introduction, which are not known in an exact manner or are not practically measurable, achieve the required high level of product integrity in track.

7.2 Blooms

Blooms made from basic oxygen steel or electric arc furnace steel that has been secondary ladle arc refined, vacuum degassed and continuously cast, shall be used for the manufacture of rails.

7.3 Rails

7.3.1 The manufacturer shall operate a procedure for the effective removal of scale during the rolling and straightening processes.

7.3.2 The cross-sectional area of the rail shall not exceed one ninth that of the bloom from which the rail is rolled.

NOTE Other mandatory processes are described in the relevant clauses within the European Standard.

7.4 Identification

7.4.1 Branding

Brand marks shall be rolled in relief on one side and in the middle of the web (see Annex A) of each rail at least once every 4 m. The brand marks on the rails shall be clearly legible and shall be 15 mm to 25 mm high, raised between 0,6 mm and 1,3 mm.

The branding line(s) to denote grade shall be 50 mm in length for the long branding line and 25 mm in length for the short branding line.

The brand marks shall include:

a) identification of the mill;

b) steel grade as shown in Table 1;

c) last two figures of the year of manufacture;

d) rail profile identification as shown in Annex A.

EXAMPLE

ROLLING MILL ___ 98 40E1

(40E1 profile rail rolled 1998, non-alloy rail steel grade R260)

7.4.2 Hot stamping

In addition to the branding requirements of 7.4.1 each rail shall be identified by a numerical and/or alphabetical code system, hot stamped on the non-branded side of the rail web by machine and each rail shall be hot stamped at least once every 5 m.

NOTE Subsequent cutting could result in more than one rail length having the same identity.

The figures and letters used shall be clearly legible and shall be 16 mm high. The stamped characters shall have a flat or radius face (1 mm to 1,5 mm wide) with bevels on each side. The letters and numbers shall be on a 10° angle from vertical and shall have rounded corners. The stamping shall be between 0,5 mm and 1,5 mm in depth along the centre of the web. The design shall be as shown in Figure 1.

The identification system employed shall be such as to enable the hot stamped marking to be collated with:

a) number of the heat from which the rail has been rolled;

b) number of the strand and position of bloom within the strand.

In the event of identification marks having been removed, omitted or requiring alteration, re-identification of such marks shall be made by rotary burr.

7.4.3 Cold stamping

Cold stamping shall only be used on the cut face of the rail within the central portion of the head, at the request of the purchaser.

7.4.4 Other identification

The steel grade may additionally be identified using paint. The purchaser shall specify the colour and position of the paint application.

8 Qualification of the manufacturer

The manufacturer has to qualify under Clause 8 of EN 13674-1:2003 and shall then be qualified for all profiles in this part of EN 13674, provided the qualification was for the profile 60E1, grade R260.

NOTE The qualifying criteria specified in EN 13674-1 may not be achieved using the rail grades specified in this part of EN 13674.

9 Acceptance tests

9.1 Laboratory tests

9.1.1 General

Laboratory tests shall be performed, during production, at frequencies as stipulated in Table 2. Results for each laboratory test shall comply with the limiting values shown in Tables 3 a) and 3 b). Additional information and other acceptance tests not covered by Tables 3 a) and 3 b) shall comply with the requirements of 9.1.2 to 9.1.6 inclusive. All rails supplied shall meet the requirements of Clause 9.

9.1.2 Chemical composition

9.1.2.1 General

The liquid chemical composition shall be determined for each heat. When the solid chemical composition is checked, this shall be carried out at the position of the tensile test piece. The chemical composition shall conform to the requirements of Tables 3 a) and 3 b).

9.1.2.2 Hydrogen

The hydrogen content of the liquid steel shall be measured by determining pressure of hydrogen in the steel using an on-line immersion probe system.

At least two liquid samples shall be taken from the first heat of any sequence using a new tundish and one from each of the remaining heats and analysed for hydrogen content (see Table 2). The first sample from the first heat in a sequence shall be taken from the tundish at the time of the maximum hydrogen concentration.

The heats shall be assessed according to hydrogen content in accordance with Table 4.

The blooms from group 1 heats shall be deemed to be satisfactory.

The blooms from group 2 heats shall be slowly cooled or isothermally treated and all heats shall be tested in the rail form.

Table 2 — Testing frequency

Test (on)	Relevant subclause	Steel grades	
		R200, R220, R260, R320Cr	R350HT
Chemical composition	9.1.2	One per heat	One per heat
Hydrogen	9.1.2.2	One per heat (2 tests from first heat in sequence)	One per heat (2 from first heat in sequence)
Microstructure	9.1.3	Not required for grades R200, R220 and R260 One per 1 000 t or part thereof for grade R320Cr	One per 50 tonnes of re-heated [a c] One per 100 tonnes of mill heat treated [a c]
Decarburisation	9.1.4	One per 1 000 t or part thereof [a b]	One per 500 tonnes of re-heated and mill heat treated [a c]
Hardness	9.1.5	One per heat [a b]	One per 50 tonnes of re-heated [a c] One per 100 tonnes of mill heat treated [a c]
Tensile	9.1.6	One calculation per heat/one test per 2 000 t [a b]	One per heat [a c]

[a] Samples shall be taken at random but only rails from blooms outside the mixing zone between heats when continuously cast in sequence.

[b] Samples shall be cut after rolling.

[c] Samples shall be cut from heat-treated rails.

Table 3 a)— Chemical composition/mechanical properties

Steel grade		% By mass									10^{-4} % (ppm) Max. H [a]	R_m Min.	elong A_5 Min.	Centre line running surface [b]
Steel name	Sample	C	Si	Mn	P max	S max	Cr	Al max.	V max.	N max.		MPa	%	hardness HBW
R200	Liquid	0,40/0,60	0,15/0,58	0,70/1,20	0,035	0,035	0,15 max.	0,004	0,030	0,009	3,0			
	Solid	0,38/0,62	0,13/0,60	0,65/1,25	0,040	0,040	0,15 max.	0,004	0,030	0,010	3,0	680	14	200/240
R220	Liquid	0,50/0,60	0,20/0,60	1,00/1,25	0,025	0,025	0,15 max.	0,004	0.030	0,008	3,0			
	Solid	0,50/0,60	0,20/0,60	1,00/1,25	0,025	0,025	0,15 max.	0,004	0,030	0,008	3,0	770	12	220/260
R260	Liquid	0,62/0,80	0,15/0,58	0,70/1,20	0,025	0,025	0,15 max.	0,004	0.030	0,009	2,5			
	Solid	0,60/0,82	0,13/0,60	0,65/1,25	0,030	0,030	0,15 max.	0,004	0.030	0,010	2,5	880	10	260/300
R320Cr	Liquid	0,60/0,80	0,50/1,10	0,80/1,20	0,020	0,025	0,80/1,20	0,004	0,18	0,009	2,5			
	Solid	0,58/0,82	0,48/1,12	0,75/1,25	0,025	0,030	0,75/1,25	0,004	0,20	0,010	2,5	1 080	9	320/360
R350HT	Liquid	0,72/0,80	0,15/0,58	0,70/1,20	0,020	0,025	0,15 max.	0,004	0,030	0,009	2,5			
	Solid	0,70/0,82	0,13/0,60	0,65/1,25	0,025	0,030	0,15 max.	0,004	0,030	0,010	2,5	1 175	9	350/390

[a] See 9.1.2.2.

[b] See Figure 8.

Table 3 b) — Maximum residual elements, % by mass

	Mo	Ni	Cu	Sn	Sb	Ti	Nb	Cu & 10 Sn	Sum of elements	
R200, R220, R260	0,02	0,10	0,15	0,030	0,020	0,025	0,01	0,35	Cr + Mo + Ni + Cu + V :	0,35
R320Cr	0,02	0,10	0,15	0,030	0,020	0,025	0,01	0,35	Ni + Cu :	0,16
R350HT	0,02	0,10	0,15	0,030	0,020	0,025	0.04	0,35	Cr + Mo + Ni + Cu + V :	0,25