
Open die steel forgings for general engineering purposes —

Part 2: Non-alloy quality and special steels

The European Standard EN 10250-2:1999 has the status of a
British Standard

National foreword

This British Standard is the official English language version of EN 10250-2:1999. It supersedes BS 29:1976 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/31, Wrought steels, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 10, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 February 2000

© BSI 08-2000

ISBN 0 580 35392 3

Amendments issued since publication

Amd. No.	Date	Comments
11041 Corrigendum No. 1	August 2000	Adds supersession details to the National foreword

ICS 77.140.20; 77.140.85

English version

Open die steel forgings for general engineering purposes - Part 2: Non-alloy quality and special steels

Pièces forgées en acier pour usage général - Partie 2:
Aciers en qualité non alliés et aciers spéciaux

Freiformschmiedestücke aus Stahl für allgemeine
Verwendung - Teil 2: Unlegierte Qualitäts- und Edelstähle

This European Standard was approved by CEN on 9 September 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Contents	Page
Foreword	3
1 Scope	4
2 Normative references	4
3 Chemical composition	4
4 Heat treatment	5
5 Mechanical properties	6
Annex A (informative) Heat treatment	10

Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 28, Steel forgings, the Secretariat of which is held by BSI.

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 April 2000, and conflicting national standards shall be withdrawn at the latest by April 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association. This European Standard is considered to be a supporting standard to those application and product standards which in themselves support an essential safety requirement of a New Approach Directive and which make reference to this European Standard.

The titles of the other parts of this European Standard are:

- Part 1: General requirements
- Part 3: Alloy special steels
- Part 4: Stainless steels

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

1 Scope

This Part of this European Standard specifies the technical delivery requirements for open die forgings, forged bars and products pre-forged and finished in ring rolling mills, manufactured from non-alloy quality and special steels and supplied in the normalized, normalized and tempered, quenched and tempered or annealed condition

NOTE: The majority of steels listed in this part of EN 10250, with properties in the quenched and tempered condition up to 160 mm thickness, are identical to steels specified in EN 10083-1 and EN 10083-2 and more extensive information on hardenability and technological properties is given in that European Standard.

General information on technical delivery conditions is given in EN 10021.

2 Normative references

This part of EN 10250 incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- | | |
|------------|---|
| EN 10003-1 | Metallic materials - Brinell hardness test – Part 1: Test method. |
| EN 10021 | General technical delivery requirements for iron and steel products |
| EN 10083-1 | Quenched and tempered steels – Part 1: Technical delivery conditions for special steels |
| EN 10083-2 | Quenched and tempered steels – Part 2: Technical delivery conditions for unalloyed quality steels |
| EN 10250-1 | Open die steel forgings for general engineering purposes – Part 1: General requirements |

3 Chemical composition

3.1 Cast analysis

The chemical composition of the steel shall be determined by cast analysis and shall conform to the analysis given in Table 1 (see A.7 and A.8, of EN 10250-1).

Measures should be taken to prevent the addition from the scrap, or other material used in the manufacture of the steel, of such elements which affect the hardenability, mechanical properties and applicability of the steel.

3.2 Product analysis

The product analysis shall not deviate from the specified cast analysis (see Table 1) by more than the values specified in Table 2 (see 9.2 of EN 10250-1).

4 Heat treatment

Heat treatment details are given in Table A.1 for guidance.

Table 1: Steel grades and chemical composition - cast analysis¹⁾

Chemical composition % (m/m)											
Steel designation		C	Si Max	Mn	P Max	S Max	Cr Max	Mo Max	Ni Max	Cr+Mo+ Ni Max	Al Min
Name	Number										
S235JRG2	1.0038	0,20 max ²⁾	0,55	1,40 max	0,045	0,045	0,30	0,08	0,30	0,48	0,020
S235J2G3	1.0116	0,17 max ²⁾	0,55	1,40 max	0,035	0,035	0,30	0,08	0,30	0,48	0,020
S355J2G3	1.0570	0,22 max ²⁾	0,55	1,60 max	0,035	0,035	0,30	0,08	0,30	0,48	0,020
C22	1.0402	0,17 to 0,24	0,40	0,40 to 0,70	0,045	0,045	0,40	0,10	0,40	0,63	—
C25	1.0406	0,22 to 0,29	0,40	0,40 to 0,70	0,045	0,045	0,40	0,10	0,40	0,63	—
C25E	1.1158	0,22 to 0,29	0,40	0,40 to 0,70	0,035	0,035	0,40	0,10	0,40	0,63	—
C30	1.0528	0,27 to 0,34	0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,63	—
C35	1.0501	0,32 to 0,39	0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,63	—
C35E	1.1181	0,32 to 0,39	0,40	0,50 to 0,80	0,035	0,035	0,40	0,10	0,40	0,63	—
C40	1.0511	0,37 to 0,44	0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,63	—
C45	1.0503	0,42 to 0,50	0,40	0,50 to 0,80	0,045	0,045	0,40	0,10	0,40	0,63	—
C45E	1.1191	0,42 to 0,50	0,40	0,50 to 0,80	0,035	0,035	0,40	0,10	0,40	0,63	—
C50	1.0540	0,47 to 0,55	0,40	0,60 to 0,90	0,045	0,045	0,40	0,10	0,40	0,63	—
C55	1.0535	0,52 to 0,60	0,40	0,60 to 0,90	0,045	0,045	0,40	0,10	0,40	0,63	—
C55E	1.1203	0,52 to 0,60	0,40	0,60 to 0,90	0,035	0,035	0,40	0,10	0,40	0,63	—
C60	1.0601	0,57 to 0,65	0,40	0,60 to 0,90	0,045	0,045	0,40	0,10	0,40	0,63	—
C60E	1.1221	0,57 to 0,65	0,40	0,60 to 0,90	0,035	0,035	0,40	0,10	0,40	0,63	—
28Mn6	1.1170	0,25 to 0,32	0,40	1,30 to 1,65	0,035	0,035	0,40	0,10	0,40	0,63	—
20Mn5	1.1133	0,17 to 0,23	0,40	1,00 to 1,50	0,035	0,035	0,40	0,10	0,40	0,63	0,020

¹⁾ At the option of the manufacturer the elements aluminium, titanium, vanadium and niobium may be added singly or in combination for grain size control purposes. Elements not quoted in Table 1 shall not be added to the steel without the agreement of the purchaser, except for the purpose of finishing the heat.

²⁾ For forgings with an equivalent diameter or thickness > 100 mm the carbon content shall be agreed between purchaser and supplier.

Table 2: Permissible deviations between the product analysis and the limiting values given in Table 1 for the cast analysis

Element	Permissible maximum content in the cast analysis %	Permissible deviation %
Carbon	< 0,55	± 0,02
	> 0,55 ≤ 0,65	± 0,03
Silicon	≤ 0,40	± 0,03
	> 0,40	± 0,04
Manganese	≤ 1,00	± 0,04
	> 1,00 ≤ 1,65	± 0,06
Phosphorus	≤ 0,045	+ 0,005
Sulfur	≤ 0,045	+ 0,005
Chromium	≤ 0,40	+ 0,05
Molybdenum	≤ 0,10	+ 0,03
Nickel	≤ 0,40	+ 0,05
Aluminium	≥ 0,020	- 0,005

5 Mechanical properties

5.1 Forgings in the normalized, normalized and tempered, and quenched and tempered condition

The mechanical properties determined on test pieces selected, prepared and tested in accordance with clauses 11 and 12 of EN 10250-1 shall conform to the property requirements given in Tables 3 and 4 respectively.

5.2 Forgings in the annealed condition (Steels C45, C55 and C60)

Representative forgings selected by a method agreed with the purchaser shall be Brinell hardness tested in designated positions using techniques described in EN 10003-1. The maximum hardness obtained shall not exceed those given for the steel in Table 5.

Table 3: Mechanical properties in the normalized and tempered conditions

Steel designation		Thickness of ruling section t_E																	
		$t_E \leq 100$ mm						$100 < t_E \leq 250$ mm						$250 < t_E \leq 500$ mm					
		R_E min N/mm ²	R_E min N/mm ²	A min %	KV min J	R_{E0} min N/mm ²	R_{E0} min N/mm ²	A min %	KV min J	R_E min N/mm ²	R_E min N/mm ²	A min %	KV min J	R_E min N/mm ²	R_E min N/mm ²	A min %	KV min J	R_E min N/mm ²	R_E min N/mm ²
Name	Number			$l^{(1)}$ tr ⁽¹⁾	$l^{(1)}$ tr ⁽¹⁾			$l^{(1)}$ tr ⁽¹⁾	$l^{(1)}$ tr ⁽¹⁾			$l^{(1)}$ tr ⁽¹⁾	$l^{(1)}$ tr ⁽¹⁾			$l^{(1)}$ tr ⁽¹⁾	$l^{(1)}$ tr ⁽¹⁾		
S235JRG2	1.0038	215	340	24	-	35	-	23	17	30	20	165	340	23	17	27	15	-	-
S235J2G3 ²⁾	1.0116	215	340	24	-	35	-	23	17	30	20	165	340	23	17	27	15	-	-
S355J2G3 ³⁾	1.0570	315	490	20	-	35	-	18	12	30	20	265	450	18	12	27	15	-	-
C22	1.0402	210	410	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C25	1.0406	230	440	23	-	35	-	23	17	30	20	190	400	23	17	25	15	390	22
C25E	1.1158	230	440	23	-	35	-	23	17	30	20	190	400	23	17	25	15	390	22
C30	1.0528	250	480	21	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-
C35	1.0501	270	520	19	-	30	-	19	15	25	15	220	480	19	15	20	12	470	18
C35E	1.1181	270	520	19	-	30	-	19	15	25	15	220	480	19	15	20	12	470	18
C40	1.0511	290	550	17	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-
C45	1.0503	305	580	16	-	-	-	16	12	18	10	240	540	16	12	15	10	530	15
C45E	1.1191	305	580	16	-	-	-	16	12	18	10	240	540	16	12	15	10	530	15
C50	1.0540	320	610	14	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-
C55	1.0535	330	640	12	-	-	-	12	9	-	-	260	600	12	9	-	-	590	11
C55E	1.1203	330	640	12	-	-	-	12	9	-	-	260	600	12	9	-	-	590	11
C60	1.0601	340	670	11	-	-	-	11	8	-	-	275	630	11	8	-	-	620	10
C60E	1.1221	340	670	11	-	-	-	11	8	-	-	275	630	11	8	-	-	620	10
28Mn6	1.1170	310	600	18	-	35	-	18	12	30	20	270	540	18	12	25	15	540	17
20Mn5	1.1133	300	530	22	20	50	35	22	20	50	35	260	500	22	20	40	27	490	22

¹⁾ l = longitudinal tr = transverse

²⁾ Impact testing shall be carried out at -20 °C.

³⁾ For steel grade 20 Mn5 max value for t_E is 750 mm.

Table 4: Mechanical properties in the quenched and tempered condition

Steel designation		Thickness of ruling section t_R															
		$t_R \leq 70$ mm					$70 < t_R \leq 160$ mm					$160 < t_R \leq 330$ mm					
		R_e min N/mm ²	R_m min N/mm ²	A min %	KV min J		R_e min N/mm ²	R_m min N/mm ²	A min %	KV min J		R_e min N/mm ²	R_m min N/mm ²	A min %	KV min J		
Name	Number			$l^{1)}$	tr ¹⁾			$l^{1)}$	tr ¹⁾			$l^{1)}$	tr ¹⁾			$l^{1)}$	tr ¹⁾
C25E	1.1158	270	450	25	-	45	-	25	18	38	25	210	390	24	16	33	20
C35E	1.1181	320	550	20	-	35	-	22	15	31	20	270	470	21	14	25	16
C45E	1.1191	370	630	17	-	25	-	18	12	22	15	320	540	17	11	20	12
C55E	1.1203	420	700	15	-	-	-	17	11	-	-	330	610	16	10	-	-
C60E	1.1221	450	750	14	-	-	-	15	10	-	-	350	670	14	9	-	-
28Mn6	1.1170	440	650	16	-	40	-	18	12	34	21	340	540	19	13	29	17
20Mn5	1.1133	400 ²⁾	550	16	-	50		20	18	45	30	300 ²⁾	500	20	18	45	30
1) l = longitudinal		tr = transverse															
2) R_p 0,2.																	

Table 5: Maximum hardness for forgings to be supplied in the annealed condition

Steel designation		Hardness
Name	Number	H B Max
C45	1.0503	207
C55	1.0535	229
C60	1.0601	241

Annex A (informative)

Heat treatment

Heat treatment details are given in Table A.1.

Table A.1: Heat treatment

Steel designation		Quenching temperature °C	Cooling medium	Tempering temperature °C	Normalizing temperature °C
Name	Number				
S235JRG2	1.0038	-	-	-	890 to 950
S235J2G3	1.0116	-	-	-	890 to 950
S355J2G3	1.0570	-	-	-	890 to 950
C22	1.0402	860 to 900	Water	550 to 660	880 to 920
C25	1.0406	860 to 900	Water	550 to 660	880 to 920
C25E	1.1158	860 to 900	Water	550 to 660	880 to 920
C30	1.0528	850 to 890	Water	550 to 660	870 to 910
C35	1.0501	840 to 880	Water or oil	550 to 660	860 to 900
C35E	1.1181	840 to 880	Water or oil	550 to 660	860 to 900
C40	1.0511	830 to 870	Water or oil	550 to 660	850 to 890
C45	1.0503	820 to 860	Water or oil	550 to 660	840 to 880
C45E	1.1191	820 to 860	Water or oil	550 to 660	840 to 880
C50	1.0540	810 to 850	Oil or water	550 to 660	830 to 870
C55	1.0535	805 to 845	Oil or water	550 to 660	825 to 865
C55E	1.1203	805 to 845	Oil or water	550 to 660	825 to 865
C60	1.0601	800 to 840	Oil or water	550 to 660	820 to 860
C60E	1.1221	800 to 840	Oil or water	550 to 660	820 to 860
28Mn6	1.1170	830 to 870	Water or oil	540 to 680	850 to 890
20Mn5	1.1133	870 to 910	Water or oil	550 to 660	880 to 930

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

Copyright subsists in all BSI publications. BSI also holds the copyright, in the UK, of the publications of the international standardization bodies. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI.

This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols, and size, type or grade designations. If these details are to be used for any other purpose than implementation then the prior written permission of BSI must be obtained.

If permission is granted, the terms may include royalty payments or a licensing agreement. Details and advice can be obtained from the Copyright Manager. Tel: 020 8996 7070.
