BRITISH STANDARD

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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

ICS 77.140.20; 77.140.85

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 It supersedes BS 29:1976 which is withdrawn.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.

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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.

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EN 10250-2

October 1999

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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

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EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Contents

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of an identical text or by endorsement, at the latest by April 2000, and conflicting national standards shall be withdrawn at the latest by April 2000.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 analysis[1)]

Chemical composition % (*m*/*m*)											
Steel designation		C	Si	Mn	P	S	Cr	Mo	Ni	Cr+Mo+	Al
			Max		Max	Max	Max	Max	Max	Ni	Min
Name	Number									Max	
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 normalized and tempered conditions

Steel designation		Thickness of ruling section t_R																					
		$t_R \leq 100$ mm						$100 < t_R \leq 250$ mm						$250 < t_R \leq 500$ mm						$500 < t_R \leq 1000$ mm [3]					
		R_e min N/mm²	R_m min N/mm²	A min %		KV min J		R_e min N/mm²	R_m min N/mm²	A min %		KV min J		R_e min N/mm²	R_m min N/mm²	A min %		KV min J		R_e min N/mm²	R_m min N/mm²	A min %		KV min J	
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	-	175	340	23	17	30	20	165	340	23	17	27	15	-	-	-	-	-	-
S235J2G3[2]	1.0116	215	340	24	-	35	-	175	340	23	17	30	20	165	340	23	17	27	15	-	-	-	-	-	-
S355J2G3[2]	1.0570	315	490	20	-	35	-	275	450	18	12	30	20	265	450	18	12	27	15	-	-	-	-	-	-
C22	1.0402	210	410	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C25	1.0406	230	440	23	-	35	-	210	420	23	17	30	20	190	400	23	17	25	15	180	390	22	16	20	15
C25E	1.1158	230	440	23	-	35	-	210	420	23	17	30	20	190	400	23	17	25	15	180	390	22	16	20	15
C30	1.0528	250	480	21	-	-	-	230	460	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C35	1.0501	270	520	19	-	30	-	245	500	19	15	25	15	220	480	19	15	20	12	210	470	18	14	17	12
C35E	1.1181	270	520	19	-	30	-	245	500	19	15	25	15	220	480	19	15	20	12	210	470	18	14	17	12
C40	1.0511	290	550	17	-	-	-	260	530	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C45	1.0503	305	580	16	-	-	-	275	560	16	12	18	10	240	540	16	12	15	10	230	530	15	11	12	10
C45E	1.1191	305	580	16	-	-	-	275	560	16	12	18	10	240	540	16	12	15	10	230	530	15	11	12	10
C50	1.0540	320	610	14	-	-	-	290	590	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C55	1.0535	330	640	12	-	-	-	300	620	12	9	-	-	260	600	12	9	-	-	250	590	11	8	-	-
C55E	1.1203	330	640	12	-	-	-	300	620	12	9	-	-	260	600	12	9	-	-	250	590	11	8	-	-
C60	1.0601	340	670	11	-	-	-	310	650	11	8	-	-	275	630	11	8	-	-	260	620	10	7	-	-
C60E	1.1221	340	670	11	-	-	-	310	650	11	8	-	-	275	630	11	8	-	-	260	620	10	7	-	-
28Mn6	1 .1170	310	600	18	-	35	-	290	570	18	12	30	20	270	540	18	12	25	15	260	540	17	11	20	15
20Mn5	1.1133	300	530	22	20	50	35	280	520	22	20	50	35	260	500	22	20	40	27	250	490	22	20	40	27

[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_R 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)]			l[1)]	tr[1)]	l[1)]	tr[1)]
C25E	1.1158	270	450	25	-	45	-	220	410	25	18	38	25	210	390	24	16	33	20
C35E	1.1181	320	550	20	-	35	-	290	490	22	15	31	20	270	470	21	14	25	16
C45E	1.1191	370	630	17	-	25	-	340	590	18	12	22	15	320	540	17	11	20	12
C55E	1.1203	420	700	15	-	-	-	360	630	17	11	-	-	330	610	16	10	-	-
C60E	1.1221	450	750	14	-	-	-	390	690	15	10	-	-	350	670	14	9	-	-
28Mn6	1.1170	440	650	16	-	40	-	390	590	18	12	34	21	340	540	19	13	29	17
20Mn5	1.1133	400[2)]	550	16	-	50		300[2)]	500	20	18	45	30	300[2)]	500	20	18	45	30

[1)] l = longitudinal tr = transverse

[2)] Rp 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

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