INTERNATIONAL STANDARD

ISO 5755

Second edition
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Sintered metal materials — Specifications

Matériaux métalliques frittés — Spécifications

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 5755 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 5, *Specifications for powder metallurgical materials (excluding hardmetals)*.

This second edition cancels and replaces the first edition (ISO 5755:1996), which has been technically revised.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Sintered metal materials — Specifications

1 Scope

This International Standard specifies the requirements for the chemical composition and the mechanical and physical properties of sintered metal materials used for bearings and structural parts.

When selecting powder metallurgical materials, it should be taken into account that the properties depend not only on the chemical composition and density, but also on the production methods. The properties of sintered materials giving satisfactory service in particular applications may not necessarily be the same as those of wrought or cast materials that might otherwise be used. Therefore liaison with prospective suppliers is recommended.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2738, *Sintered metal materials, excluding hardmetals — Permeable sintered metal materials — Determination of density, oil content and open porosity.*

ISO 2739, *Sintered metal bushes — Determination of radial crushing strength.*

ISO 2740, *Sintered metal material, excluding hardmetals — Tensile test pieces.*

ISO 2795, *Plain bearings — Sintered bushes — Dimensions and tolerances.*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature.*

3 Sampling

Sampling shall be carried out in accordance with the relevant International Standards.

4 Test methods for normative properties

4.1 General

The following test methods shall be used to determine the normative properties given in Tables 1 to 11.

4.2 Chemical analysis

Whenever possible, and always in cases of dispute, the methods of chemical analysis shall be those specified in the relevant International Standards. If no International Standard is available, the method may be agreed upon and specified at the time of enquiry and order.

4.3 Open porosity

The open porosity shall be determined in accordance with ISO 2738.

4.4 Radial crushing strength

The radial crushing strength shall be determined in accordance with ISO 2739.

4.5 Tensile strength

The ultimate tensile strength shall be determined in accordance with ISO 2740 and ISO 6892.

4.6 Tensile yield strength

The yield strength shall be determined in accordance with ISO 2740 and ISO 6892.

4.7 Mechanical properties

4.7.1 General

The mechanical properties given in Tables 1 to 11 were determined on pressed and sintered test pieces at mean chemical composition and are intended as a guide to initial selection of materials (see clause 1). They may also be used as a basis for specifying any special tests that may be indicated on the drawing.

The mechanical properties shall neither be calculated from hardness values, nor be determined on tensile test pieces taken from a component and used for verifying the values given in Tables 1 to 11. If the customer requires that a specified level of mechanical properties be obtained by tests on the component, these shall be agreed with the supplier and shall be stated on the drawing and/or any technical documentation of the customer referred to on the drawing.

4.7.2 Tensile properties

The normative values for yield strength shall be determined in accordance with ISO 6892, using pressed and sintered test pieces made in accordance with ISO 2740. For heat-treated materials, tensile strength and yield strength are approximately equal and in this case tensile strength, determined on machined test pieces according to ISO 2740, is specified.

4.7.3 Radial crushing strength

The radial crushing strength shall be determined in accordance with ISO 2739. The wall thicknesses of test pieces to be used shall be in the range covered by ISO 2795. For test pieces outside this range, the specified radial crushing strength values are different and shall be agreed between customer and supplier.

5 Specifications

The chemical composition and mechanical properties are given in Tables 1 to 11.

The liquid lubricant content of materials for bearings, impregnated with liquid lubricant, shall be not less than 90 % of the measured open porosity.

6 Designations

Designations shall be in accordance with annex A.

Table 1 — Materials for bearings: iron, iron-copper, iron-bronze and iron-carbon-graphite

Parameter	Symbol	Unit	Iron		Iron-copper		Iron-bronze [a]				Iron-carbon-graphite [a]		
			Grade [b]		Grade [b]		Grade [b]				Grade [b]		
Chemical composition			-F-00-K170	-F-00-K220	-F-00C2-K200	-F-00C2-K250	-F-03C36T-K90	-F-03C36T-K120	-F-03C45T-K70	-F-03C45T-K100	-F-03G3-K70	-F-03G3-K80	
C combined [c]		%	< 0,3	< 0,3	< 0,3	< 0,3	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	Normative values
Cu		%	—	—	1 to 4	1 to 4	34 to 38	34 to 38	43 to 47	43 to 47	—	—	
Fe		%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Sn		%	—	—	—	—	3,5 to 4,5	3,5 to 4,5	4,5 to 5,5	4,5 to 5,5	—	—	
Graphite		%	—	—	—	—	0,3 to 1,0	0,3 to 1,0	< 1,0	< 1,0	2,0 to 3,5	2,0 to 3,5	
Total other elements max.		%	2	2	2	2	2	2	2	2	2	2	
Open porosity min.	P	%	22	17	22	17	24	19	24	19	20	13	
Radial crushing strength min.	K	MPa	170	220	200	250	90 to 265	120 to 345	70 to 245	100 to 310	70 to 175	80 to 210	
Density (dry)	ρ	g/cm^3	5,8	6,2	5,8	6,2	5,8	6,2	5,6	6,0	5,6	6,0	d
Coefficient of linear expansion [d]		$10^{-6}\ K^{-1}$	12	12	12	12	14	14	14	14	12	12	d

a The range of values given for radial crushing strength (K) indicates the necessity to maintain a balance between combined carbon and free graphite.

b All materials can be impregnated.

c On the basis of iron phase only.

d Informative values.

Table 2 — Non-ferrous materials for bearings

Parameter		Symbol	Unit	Bronze			Bronze with graphite			
				Grade [a]			Grade [a]			
				-C-T10-K110	-C-T10-K140	-C-T10-K180	-C-T10G-K90	-C-T10G-K120	-C-T10G-K160	
Chemical composition										
Cu			%	Balance	Balance	Balance	Balance	Balance	Balance	Normative values
Sn			%	8,5 to 11,0	8,5 to 11,0	8,5 to 11,0	8,5 to 11,0	8,5 to 11,0	8,5 to 11,0	Normative values
Graphite			%	—	—	—	0,5 to 2,0	0,5 to 2,0	0,5 to 2,0	Normative values
Total other elements max.			%	2	2	2	2	2	2	Normative values
Open porosity	min.	P		27	22	15	27	22	17	Normative values
Radial crushing strength	min.	K		110	140	180	90	120	160	Normative values
Density (dry)		ρ	g/cm^3	6,1	6,6	7,0	5,9	6,4	6,8	b
Coefficient of linear expansion [b]			10^{-6} K^{-1}	18	18	18	18	18	18	b

a All materials can be impregnated.

b Informative values.

Table 3 — Ferrous materials for structural parts: iron and carbon steel

Parameter	Symbol	Unit	Iron			Carbon steel									
			Grade			Grade									
			-F-00-100	-F-00-120	-F-00-140	-F-05-140	-F-05-170	-F-05-340H [a]	-F-05-480H [a]	-F-08-210	-F-08-240	-F-08-450H [b]	-F-08-550H [b]	
Chemical composition														Normative values
C combined		%	< 0,3	< 0,3	< 0,3	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	
Cu		%	—	—	—	—	—	—	—	—	—	—	—	
Fe		%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements max.		%	2	2	2	2	2	2	2	2	2	2	2	
Tensile yield strength min.	$R_{p0,2}$	MPa	100	120	140	140	170			210	240			
Ultimate tensile strength min.	R_m	MPa						340	480			450	550	
Apparent hardness		HV5	62	75	85	90	120	280 HV10	300 HV10	120	140	320 HV10	360 HV10	Informative values
		Rockwell	60 HRF	70 HRF	80 HRF	40 HRB	60 HRB	20 HRC	25 HRC	60 HRB	70 HRB	28 HRC	33 HRC	
Density	ρ	g/cm^3	6,7	7,0	7,3	6,6	7,0	6,6	7,0	6,6	7,0	6,6	7,0	
Tensile strength	R_m	MPa	170	210	260	220	275	410	550	290	390	520	620	
Tensile yield strength	$R_{p0,2}$	MPa	120	150	170	160	200	a	a	240	260	c	c	
Elongation	A_{25}	%	3	4	7	1	2	nm [d]	nm [d]	1	1	nm [d]	nm [d]	
Young's Modulus		GPa	120	140	160	115	140	115	140	115	140	115	140	
Poisson's ratio			0,25	0,27	0,28	0,25	0,27	0,25	0,27	0,25	0,27	0,25	0,27	
Unnotched Charpy Impact		J	8	24	47	5	8	4	5	5	7	5	7	
Compressive yield strength	(0,1 %)	MPa	120	125	130	210	225	300	420	290	290	400	550	
Transverse rupture strength		MPa	340	500	660	440	550	720	970	510	690	790	950	
Fatigue limit 90 % survival [e]		MPa	65	80	100	80	105	160	220	120	170	210	260	

NOTE These materials may be supplied with additives to improve machinability. The properties remain unchanged.

[a] Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,5 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

[b] Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,8 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

[c] Tensile strength and tensile yield strength are approximately the same for heat treated materials.

[d] nm = not measurable.

[e] 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

Table 4 — Ferrous materials for structural parts: copper steel and copper-carbon steel

Parameter	Symbol	Unit	Copper steel		Copper-carbon steel								
			Grade		Grade								
Chemical composition			-F-00C2-140	-F-00C2-175	-F-05C2-270	-F-05C2-300	-F-05C2-500H [a]	-F-05C2-620H [a]	-F-08C2-350	-F-08C2-390	-F-08C2-500H [b]	-F-05C2-620H [b]	
C combined		%	< 0,3	< 0,3	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	Normative values
Cu		%	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	
Fe		%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements max.		%	2	2	2	2	2	2	2	2	2	2	
Tensile yield strength min.	$R_{p0,2}$	MPa	140	175	270	300	c	c	350	390	c	c	
Ultimate tensile strength min.	R_m	MPa					500	620			500	620	
Apparent hardness		HV5	70	90	115	150	310 HV 10	390 HV 10	140	165	360 HV 10	430 HV 10	Informative values
		Rockwell	26 HRB	39 HRB	57 HRB	68 HRB	27 HRC	36 HRC	70 HRB	78 HRB	33 HRC	40 HRC	
Density	ρ	g/cm^3	6,6	7,0	6,6	7,0	6,6	7,0	6,6	7,0	6,6	7,0	
Tensile strength	R_m	MPa	210	235	325	390	580	690	390	480	570	690	
Tensile yield strength	$R_{p0,2}$	MPa	180	205	300	330	c	c	360	420	c	c	
Elongation	A_{25}	%	2	3	nm [d]	1	nm [d]	nm [d]	nm [d]	nm [d]	nm [d]	nm [d]	
Young's Modulus		GPa	115	140	115	140	115	140	115	140	115	140	
Poisson's ratio			0,25	0,27	0,25	0,27	0,25	0,27	0,25	0,27	0,25	0,27	
Unnotched Charpy Impact		J	7	8	7	10	5	7	7	8	6	6	
Compressive yield strength	(0,1 %)	MPa	160	185	380	400	560	660	450	480	560	690	
Transverse rupture strength		MPa	390	445	620	760	800	930	800	980	830	1 000	
Fatigue limit 90 % survival [e]		MPa	80	89	130	200	220	260	150	200	230	270	
Fatigue limit 50 % survival [f]		MPa			110	160			120	150			

NOTE These materials may be supplied with additives to improve machinability. The properties remain unchanged.

a Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,5 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

b Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,8 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

c Tensile strength and tensile yield strength are approximately the same for heat-treated materials.

d nm = not measurable.

e 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

f 50 % fatigue endurance limit in 4-point plane bending. Non-machined test pieces in accordance with ISO 3928.

Table 5 — Ferrous materials for structural parts: phosphorus steels

Parameter	Symbol	Unit	Phosphorus steel [a]		Phosphorus carbon steel		Copper-phosphorus steel		Copper-phosphorus-carbon steel		
			Grade		Grade		Grade		Grade		
Chemical composition			-F-00P05-180	-F-00P05-210	-F-05P05-270	-F-05P05-320	-F-00C2P-260	-F-00C2P-300	-F-05C2P-320	-F-05C2P-380	
C combined		%	< 0,1	< 0,1	0,3 to 0,6	0,3 to 0,6	< 0,3	< 0,3	0,3 to 0,6	0,3 to 0,6	Normative values
Cu		%	—	—	—	—	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	
P		%	0,40 to 0,50	0,40 to 0,50	0,40 to 0,50	0,40 to 0,50	0,40 to 0,50	0,40 to 0,50	0,40 to 0,50	0,40 to 0,50	
Fe		%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements max.		%	2	2	2	2	2	2	2	2	
Tensile yield strength min.	$R_{p0,2}$	MPa	180	210	270	320	260	300	320	380	
Apparent hardness		HV5	70	120	130	150	120	140	140	160	Informative values
		Rockwell	40 HRB	60 HRB	65 HRB	72 HRB	60 HRB	69 HRB	69 HRB	74 HRB	
Density	ρ	g/cm³	6,6	7,0	6,6	7,0	6,6	7,0	6,6	7,0	
Tensile strength	R_m	MPa	300	400	400	480	400	500	450	550	
Tensile yield strength	$R_{p0,2}$	MPa	210	240	305	365	300	340	360	400	
Elongation	A_{25}	%	4	9	3	5	3	6	2	3	
Young's Modulus		GPa	115	140	115	140	115	140	115	140	
Poisson's ratio			0,25	0,27	0,25	0,27	0,25	0,27	0,25	0,27	
Unnotched Charpy Impact		J	18	30	9	15					
Transverse rupture strength		MPa	600	900	700	1000			820	1120	
Fatigue limit 50 % survival [b]		MPa	110	140	140	175	130	160	150	180	

[a] Consultation with the supplier is recommended before these materials are used in magnetic applications. Some soft magnetic PM materials are standardized in IEC 60404-8-9.

[b] 50 % fatigue endurance limit in 4-point plane bending. Non-machined test pieces in accordance with ISO 3928.

Table 6 — Ferrous materials for structural parts: nickel steels

Parameter	Symbol	Unit	Nickel steels											
			Grade											
Chemical composition			-F-05N2-140	-F-05N2-180	-F-05N2-550H [a]	-F-05N2-800H [a]	-F-08N2-260	-F-08N2-600H [b]	-F-08N2-900H [b]	-F-05N4-180	-F-05N4-240	-F-05N4-600H [a]	-F-05N4-900H [a]	
C combined		%	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	Normative values
Ni		%	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	1,5 to 2,5	3,5 to 4,5	3,5 to 4,5	3,5 to 4,5	3,5 to 4,5	
Fe		%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements max.		%	2	2	2	2	2	2	2	2	2	2	2	
Tensile yield strength min.	$R_{p0,2}$	MPa	140	180	c	c	260	c	c	180	240	c	c	
Ultimate tensile strength min.	R_m	MPa			550	800		600	900			600	900	
Apparent hardness		HV5	80	140	330 HV 10	350 HV 10	160	350 HV 10	380 HV 10	107	145	270 HV 10	350 HV 10	Informative values
		Rockwell	44 HRB	62 HRB	23 HRC	31 HRC	74 HRB	26 HRC	35 HRC	53 HRB	71 HRB	21 HRC	31 HRC	
Density	ρ	g/cm^3	6,6	7,0	6,6	7,0	7,0	6,7	7,0	6,6	7,0	6,6	7,0	
Tensile strength	R_m	MPa	280	360	620	900	430	620	1000	285	410	610	930	
Tensile yield strength	$R_{p0,2}$	MPa	170	220	c	c	300	c	c	220	280	c	c	
Elongation	A_{25}	%	1,5	2,5	nm [d]	nm [d]	1,5	nm [d]	nm [d]	1,0	3,0	nm [d]	nm [d]	
Young's Modulus		GPa	115	140	115	140	140	120	140	115	140	115	140	
Poisson's ratio			0,25	0,27	0,25	0,27	0,27	0,25	0,27	0,25	0,27	0,25	0,27	
Unnotched Charpy Impact		J	8	20	5	7	15	5	7	8	20	6	9	
Compressive yield strength	(0,1 %)	MPa	230	270	530	650	350	680	940	240	280	510	710	
Transverse rupture strength		MPa	450	740	830	1200	800	830	1280	500	830	860	1380	
Fatigue limit 90 % survival [e]		MPa	100	130	180	260	150	200	320	120	150	190	290	

a Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,5 % carbon potential, oil quenched and tempered at 260 °C for 1 h.

b Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,8 % carbon potential, oil quenched and tempered at 260 °C for 1 h.

c Tensile strength and tensile yield strength are approximately equal for heat-treated materials.

d nm = not measurable.

e 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

Table 7 — Ferrous materials for structural parts: diffusion-alloyed nickel-copper-molybdenum steels

Parameter		Symbol	Unit	Nickel-copper-molybdenum steels [a]										
				Grade										
Chemical composition				-FD-05N2C-360	-FD-05N2C-400	-FD-05N2C-440	-FD-05N2C -950H [b]	-FD-05N2C -1100H [b]	-FD-05N4C-400	-FD-05N4C-420	-FD-05N4C-450	-FD-05N4C -930H [b]	-FD-05N4C -1100H [b]	
C combined			%	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	0,3 to 0,6	Normative values
Ni			%	1,5 to 2,0	1,5 to 2,0	1,5 to 2,0	1,5 to 2,0	1,5 to 2,0	3,5 to 4,5	3,5 to 4,5	3,5 to 4,5	3,5 to 4,5	3,5 to 4,5	
Cu			%	1,0 to 2,0	1,0 to 2,0	1,0 to 2,0	1,0 to 2,0	1,0 to 2,0	1,0 to 2,0	1,0 to 2,0	1,0 to 2,0	1,0 to 2,0	1,0 to 2,0	
Mo			%	0,4 to 0,6	0,4 to 0,6	0,4 to 0,6	0,4 to 0,6	0,4 to 0,6	0,4 to 0,6	0,4 to 0,6	0,4 to 0,6	0,4 to 0,6	0,4 to 0,6	
Fe			%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements	max.		%	2	2	2	2	2	2	2	2	2	2	
Tensile yield strength	min.	$R_{p0,2}$	MPa	360	400	440	c	c	400	420	450	c	c	
Ultimate tensile strength	min.	R_m	MPa				950	1100				930	1100	
Apparent hardness			HV5	155	180	210	400 HV 10	480 HV 10	170	200	230 HV 10	390 HV 10	460 HV 10	Informative values
			Rockwell	73 HRB	80 HRB	86 HRB	37 HRC	45 HRC	82 HRB	86 HRB	92 HRB	36 HRC	43 HRC	
Density		ρ	g/cm^3	6,9	7,1	7,4	7,1	7,4	6,9	7,1	7,4	7,1	7,4	
Tensile strength [d]		R_m	MPa	540	590	680	1020	1170	650	750	875	1000	1170	
Tensile yield strength [d]		$R_{p0,2}$	MPa	390	420	460	c	c	440	460	485	c	c	
Elongation		A_{25}	%	2	3	4	nm [e]	nm [e]	1	2	3	nm [e]	nm [e]	
Young's Modulus			GPa	135	150	170	150	170	135	150	170	150	170	
Poisson's ratio				0,27	0,27	0,28	0,27	0,28	0,27	0,27	0,28	0,27	0,28	
Unnotched Charpy Impact			J	14	22	38	11	15	21	28	39	10	15	
Compressive yield strength		(0,1 %)	MPa	350	380	430	1 170	1 380	410	440	510	1 060	1 240	
Transverse rupture strength			MPa	1 040	1 200	1 450	1 420	1 650	1 220	1 380	1 630	1 420	1 650	
Fatigue limit 90 % survival [f]			MPa	190	220	260	400	490	200	240	290	350	410	
Fatigue limit 50 % survival [g]			MPa	170	200	240	380	—	190	220	260	—	—	

[e] nm = not measurable.

[a] These materials are produced from diffusion-alloyed powders with the addition of elemental graphite.

[c] Tensile strength and tensile yield strength are approximately equal for heat-treated materials.

[b] Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,5 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

[d] Properties were derived from pressed, sintered and heat treated test pieces (not machined) in accordance with ISO 2740.

[f] 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

[g] 50 % fatigue endurance limit in 4 point plane bending tests. Non machined test pieces in accordance with ISO 3928.

Table 8 — Ferrous materials for structural parts: pre-alloyed nickel-molybdenum-manganese steels

Parameter		Symbol	Unit	Nickel-molybdenum-manganese steels [a] Grade: -FL-05M07N-620H [b, c]	-FL-05M07N-830H [b, c]	-FL-05M1-940H [c, d]	-FL-05M1-1120H [c, d]	-FL-05N2M-650H [c, e]	-FL-05N2M-860H [c, e]	
Chemical composition										Normative values
C Combined			%	0,4 to 0,7	0,4 to 0,7	0,4 to 0,7	0,4 to 0,7	0,4 to 0,7	0,4 to 0,7	
Ni			%	0,4 to 0,5	0,4 to 0,5	—	—	1,75 to 1,90	1,75 to 1,90	
Mo			%	0,55 to 0,85	0,55 to 0,85	0,75 to 0,95	0,75 to 0,95	0,50 to 0,85	0,50 to 0,85	
Mn			%	0,2 to 0,5	0,2 to 0,5	0,10 to 0,25	0,10 to 0,25	0,1 to 0,6	0,1 to 0,6	
Fe			%	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements max.			%	2	2	2	2	2	2	
Tensile yield strength	min.	$R_{p0,2}$	MPa	f	f	f	f	f	f	
Ultimate tensile strength	min.	R_m	MPa	620	830	940	1 120	650	860	
Apparent hardness			HV10	340	380	350	380	320	380	Informative values
			Rockwell	30 HRC	36 HRC	32 HRC	36 HRC	28 HRC	35 HRC	
Density		ρ	g/cm^3	6,7	7,0	7,0	7,2	6,7	7,0	
Tensile strength [g]		R_m	MPa	690	900	1 020	1 190	720	930	
Elongation [g]		A_{25}	%	nm [h]	nm [h]	nm [h]	nm [h]	nm [h]	nm [h]	
Young's Modulus			GPa	120	140	140	155	120	140	
Poisson's ratio				0,25	0,27	0,27	0,27	0,25	0,27	
Unnotched Charpy Impact			J	8	11	10	15	7	12	
Compressive yield strength		(0,1 %)	MPa	650	970	1 140	1 270	750	1 000	
Transverse rupture strength			MPa	1 020	1 280	1 480	1 750	1 100	1 390	
Fatigue limit 90 % survival [i]			MPa	240	300	310	360	250	330	

a These materials are produced from pre-alloyed powders with the addition of elemental graphite.

b Pre-alloy base powder with a nominal composition 0,45 % Ni, 0,7 % Mo, 0,35 % Mn, balance Fe.

c Austenitized for 30 min at 850 °C in a protective atmosphere with a 0,6 % carbon potential, oil quenched and tempered for 1 h at 180 °C.

d Pre-alloy base powder with a nominal composition 0,85 % Mo, 0,2 % Mn, balance Fe.

e Pre-alloy base powder with a nominal composition 1,8 % Ni, 0,7 % Mo, 0,3 % Mn, balance Fe.

f Tensile strength and tensile yield strength are approximately the same for heat-treated materials.

g As heat treated tensile properties are derived from machined test bars in accordance with ISO 2740.

h nm = not measurable.

i 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

Table 9 — Ferrous materials for structural parts: copper or copper alloy infiltrated steels

Parameter		Symbol	Unit	Copper infiltrated steels				
				Grade				
				-FX-08C10-340	-FX-08C10-760H [a]	-FX-08C20-410	-FX-08C20-620H [a]	
Chemical composition								
C Combined [b]			%	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	0,6 to 0,9	Normative values
Cu			%	8 to 15	8 to 15	15 to 25	15 to 25	
Fe			%	Balance	Balance	Balance	Balance	
Total other elements max.			%	2	2	2	2	
Tensile yield strength	min.	$R_{p0,2}$	MPa	340	c	410	c	
Ultimate tensile strength	min	R_m	MPa		760		620	
Apparent hardness			HV5	210	460 HV 10	210	390 HV 10	Informative values
			Rockwell	89 HRB	43 HRC	90 HRB	36 HRC	
Density		ρ	g/cm^3	7,3	7,3	7,3	7,3	
Tensile strength		R_m	MPa	600	830	550	690	
Tensile yield strength		$R_{p0,2}$	MPa	410	c	480	c	
Elongation		A_{25}	%	3	nm [d]	1	nm [d]	
Young's Modulus [e]			GPa	160	160	145	145	
Poisson's ratio [e]				0,28	0,28	0,24	0,24	
Unnotched Charpy Impact			J	14	9	9	7	
Compressive yield strength		(0,1 %)	MPa	490	790	480	510	
Transverse rupture strength			MPa	1 140	1 300	1 080	1 100	
Fatigue limit 90 % survival [f]			MPa	230	280	160	190	

NOTE All data are based on single pass infiltration.

a Austenitized at 850 °C for 30 min in a protective atmosphere with a 0,8 % carbon potential, oil quenched and tempered at 180 °C for 1 h.

b On the basis of iron phase only.

c Tensile strength and tensile yield strength are approximately equal for heat-treated materials.

d nm = not measurable.

e Values derived from ultrasonic resonance testing.

f 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

Table 10 — Ferrous materials for structural parts: austenitic, martensitic and ferritic stainless steels

Parameter	Symbol	Unit	Austenitic							Martensitic	Ferritic			
			Grade							Grade	Grade			
			-FL303-170N [a]	-FL303-260N [b]	-FL304-210N [a]	-FL304-260N [b]	-FL316-170N [a]	-FL316-260N [b]	-FL316-150 [c]	-FL410-620H [d]	-FL410-140 [e]	-FL430-170 [e]	-FL434-170 [e]	
Type			303	303	304	304	316	316	316 L	410	410 L	430 L	434 L	
Chemical composition														Normative values
Cr		%	17 to 19	17 to 19	18 to 20	18 to 20	16 to 18	16 to 18	16 to 18	11,5 to 13,5	11,5 to 13,5	16 to 18	16 to 18	
Ni		%	8 to 13	8 to 13	8 to 12	8 to 12	10 to 14	10 to 14	10 to 14	—	—	—	—	
Mo		%	—	—	—	—	2 to 3	2 to 3	2 to 3	—	—	—	0,75 to 1,25	
S		%	0,15 to 0,30	0,15 to 0,30	—	—	—	—	—	< 0,03	< 0,03	< 0,03	< 0,03	
C		%	< 0,15	< 0,15	< 0,08	< 0,08	< 0,08	< 0,08	< 0,03	0,10 to 0,25	< 0,03	< 0,03	< 0,03	
N		%	0,2 to 0,6	0,2 to 0,6	0,2 to 0,6	0,2 to 0,6	0,2 to 0,6	0,2 to 0,6	< 0,03	0,2 to 0,6	< 0,03	< 0,03	< 0,03	
Fe		%	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Total other elements max.		%	3	3	3	3	3	3	3	3	3	3	3	
Tensile yield strength min.	$R_{p0,2}$	MPa	170	260	210	260	170	260	150	f	140	170	170	
Ultimate tensile strength min.	R_m	MPa								620 [d]				
Apparent hardness		HV5	120	180	125	140	115	125	75	300 HV 10 [d]	80	80	95	Informative values
		Rockwell	62 HRB	70 HRB	61 HRB	68 HRB	59 HRB	65 HRB	45 HRB	23 HRC [d]	45 HRB	45 HRB	50 HRB	
Density	ρ	g/cm^3	6,4	6,9	6,4	6,9	6,4	6,9	6,9	6,5	6,9	7,1	7,0	
Tensile strength	R_m	MPa	270	470	300	480	280	480	390	720	330	340	340	
Tensile yield strength	$R_{p0,2}$	MPa	220	310	260	310	230	310	210	f	180	210	210	
Elongation	A_{25}	%	nm [g]	10	nm [g]	8	nm [g]	13	21	nm [g]	16	20	15	
Young's Modulus		GPa	105	140	105	140	105	140	140	125	165	170	165	
Poisson's ratio			0,25	0,27	0,25	0,27	0,25	0,27	0,27	0,25	0,27	0,27	0,27	
Unnotched Charpy Impact		J	5	47	5	34	7	65	88	3	68	108	88	
Compressive yield strength	(0,1 %)	MPa	260	320	260	320	250	320	220	640	190	230	230	
Transverse rupture strength		MPa	590	nm [g]	nm [g]	nm [g]	nm [g]	nm [g]	nm [g]	780	nm [g]	nm [g]	nm [g]	
Fatigue limit 90 % survival [h]		MPa	90	145	105	160	75	130	115	240	125	170	150	

NOTE 1 The corrosion properties of sintered stainless steel are not necessarily the same as those of solid stainless steels. In general the austenitic materials can be ranked as type 316L being the best followed by 304 and then 303. These as a group are all better than any of the martensitic or ferritic materials. Type 434 is the best of these materials.

NOTE 2 Sintering may also affect corrosion resistance so that grade -FL 316-150 may be more resistant than the grades sintered in nitrogen-containing atmospheres.

NOTE 3 Before using any sintered stainless steel a corrosion test under expected environmental conditions is recommended.

a Grades -FL303-170N, -FL304-210N and -FL316-170N sintered in a nitrogen-containing atmosphere e.g. dissociated ammonia at 1 150 °C.

b Grades -FL303-260N, -FL304-260N and -FL316-260N sintered in a nitrogen-containing atmosphere e.g. dissociated ammonia at 1 290 °C.

c Grade -FL316-150 sintered in a nitrogen-free atmosphere e.g. hydrogen or vacuum backfilled with argon, at 1 290 °C.

d Grade FL410-620H sintered in a nitrogen-containing atmosphere e.g. dissociated ammonia, at 1 150 °C, hardened by rapid cooling and tempered at 180 °C for 1 h.

e Grades -FL410-140, -FL430-170 and -FL434-170 sintered in a nitrogen-free atmosphere e.g. hydrogen or vacuum backfilled with argon at 1 290 °C.

f Tensile strength and tensile yield strength are approximately the same for heat treated materials.

g nm = not measurable.

h 90 % fatigue endurance limit in rotating bending tests. Machined test pieces in accordance with ISO 3928.

Table 11 — Non-ferrous materials for structural parts: copper based alloys

Parameter	Symbol	Unit	Brass				Bronze	Nickel silver	
			Grade				Grade	Grade	
Chemical composition			-CL-Z20-75	-CL-Z20-80	-CL-Z30-100	-CL-Z30-110	-C-T10-90R [a]	-CL-N18Z-120	
Sn		%	—	—	—	—	8,5 to 11,0	—	Normative values
Zn		%	Balance	Balance	Balance	Balance	—	Balance	
Ni		%	—	—	—	—	—	16 to 20	
Cu		%	77 to 80	77 to 80	68 to 72	68 to 72	Balance	62 to 66	
Total other element max.		%	2	2	2	2	2	2	
Tensile yield strength min.	$R_{p0,2}$	MPa	75	80	100	110	90	120	
Apparent hardness		HV5	50	68	72	84	68	82	Informative values
		Rockwell	73 HRH	82 HRH	84 HRH	92 HRH	82 HRH	90 HRH	
Density	ρ	g/cm^3	7,6	8,0	7,6	8,0	7,2	7,9	
Tensile strength	R_m	MPa	160	240	190	230	150	230	
Tensile yeld strength	$R_{p0,2}$	MPa	90	120	110	130	110	140	
Elongation	A_{25}	%	9	18	14	17	4	11	
Young's Modulus		GPa	85	100	80	90	60	95	
Poisson's ratio (compression)			0,31	0,31	0,31	0,31	0,31	0,31	
Unnotched Charpy Impact		J	37	61	31	52	5	33	
Compressive yield strength	(0,1 %)	MPa	80	100	120	130	140	170	
Transverse rupture strength		MPa	360	480	430	590	310	500	

[a] The letter R indicates that the material has been repressed.

Annex A
(normative)

Designation system

A.1 Designation of materials

The designation system to be used for sintered metal materials specified in this International Standard is in accordance with ISO/IEC Directives Part 2:1992.

A.2 Description block

The description block shall contain the letter P, denoting powder metallurgical materials.

A.3 Identity block

The identity block shall contain the number of this International Standard, ISO 5755, followed by the individual item block.

A.4 Individual item block

A.4.1 First group

The first group of the individual item block shall consist of one to three capital letters, describing the base metal and ways of adding alloying elements:

— F = Plain iron powder or iron powder with admixed alloying additives

— FD = Iron powder with diffusion-alloyed additives

— FL = Pre-alloyed steel powder

— FX = Copper-infiltrated steel

— C = Copper powder with admixed alloying additives

— CL = Pre-alloyed copper-base powder

— FLD = Pre-alloyed steel powder with diffusion-alloyed additives (this will be used in future revisions)

— FLA = Pre-alloyed steel powder with admixed alloying additives (this will be used in future revisions)