GOST : 801-78

Title : BALL-BEARING STEEL SPECIFICATIONS

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NOTE: 1) Калиброванная сталь has been translated as "calibrated steel" (vide GOST 1051-59); Bright annealed is the more common expression.

2) This GOST standard contains references to the following other GOST standard

GOST	2590-71	GOST	12350-66
GOST	2591-71	GOST	12352-66
GOST	3693-77	GOST	14305-66
GOST	103-76	GOST	12503-75
GOST	7417-75	GOST	21120-75
GOST	14955-77	GOST	1763-68
GOST	7565-73	GOST	7566-58
GOST	20560-75	GOST	1778-70
GOST	12344-66	GOST	7564-73
GOST	12345-66	GOST	9013-59
GOST	12346-66	GOST	2789-73
GOST	12347-77	GOST	4461-77
GOST	12348-66	GOST	3118-77

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Name:

Signature

Date

Checked by
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(A.K. KUNDU)
20/12/1989.84

УДК
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Group B32 (V32)

USSR STATE STANDARD

(1)

Ball-bearing steel

Specifications

GOST 801-78
This supercedes
GOST 801-60

Valid upto 01.01.1985

The present standard pertains to hot-rolled calibrated and special surface-finished steel (with or without drawing) having diameter or thickness upto and including 250 mm, meant for manufacturing rings, balls and rollers of bearings.

Steel should be manufactured in electric arc vacuum furnaces open hearth furnaces or by electric slag remelting process.

This standard relates to ingots, slabs, pipes, sheets, forgings, semi-finished rolled stock and wire as far as norms for chemical composition are concerned.

1. Grades

1.1 Ball-bearing steel is manufactured in grades ШХ15, ШХ4, ШХ15СГ and ШХ 20СГ.

Note: Letters and numbers in grade designations denote the following

Х - chromium alloy.

4, 15, 20 - chromium content (0.4; 1.5; 2.0%) by weight

СГ - silicon and manganese alloy;

Ш - at the end of grade - produced by electric slag remelting process.

Ш - in the beginning of the grade - bearing

2. Assortment

2.1 Steel is manufactured in bars, strips and bundles of round, square and rectangular sections.

2.2 As regards shape, sizes and tolerance, steel should conform to the requirements of:

GOST 2590-71 - for hot-rolled round steel;

GOST 2591-71 - for hot-rolled square steel;

GOST 4693-77 - for square billets;

GOST 103-76 - for hot-rolled strips;

GOST 7417-75 - for calibrated rounds of accuracy class 4 with additional sizes in accordance with mandatory annexure 1.

GOST 14955-77 - for rounds with special surface finish of accuracy class 4 of group B and

2.3 Steel should be manufactured in the following lengths:

2.8 to 4.0 m - hot-rolled rounds with diameter upto 65 mm;

2.0 to 4.0 m - hot-rolled rounds with diameter above 65 mm;

2.0 to 4.0 m - hot-rolled squares;

3.0 to 4.5 m - calibrated steel with special surface finish.

Not more than 10% of a batch by weight may consist of rods of diameter or thickness upto 65 mm and length not less than 2 mm.

Steel may be manufactured with length upto 6 mm with the customer's concurrence.

2.4 Calibrated steel with special surface finish of diameter upto 25 mm may be manufactured as rols or bundles and above 25 mm - as rods.

2.5 Bundles should weight:

50 to 300 kg - for steel of diameter upto 12 mm;

200 to 500 kg - for steel of diameter above 12 mm.

Not more than 10% of the batch by wight may consist of bundles of lesser weight.

2.6 Internal diameter of bundles should be:

hot-rolled steel

550 to 850 mm for diameters from 6 to 12 mm

750 to 1100mm diameters over 12 upto 20 mm

calibrated steel with special surface finish

200 to 550 mm for diameters upto 5 mm

550 to 850 mm for diameters over 5 to 12 mm

750 to 1100mm for diameters over 12 to 25 mm

2.7 Curvature in hot-rolled annealed rods and strips should not exceed 0.4% of the length.

Curvature in hot-rolled rods should be less than 0.2% of the length in order to meet customer's requirement for manufacturing roller bearings on automatic lines.

Curvature in calibrated steel rods should not exceed:

0.2% of the length for rods of diameter upto 25 mm;

0.1 % of the length for rods of diameter over 25 mm.

Curvature in steel rods with special surface finish should not exceed 0.05 % of the length.

2.8 Ends of rods, bundles and strips of hot-rolled, calibrated steel with special surface finish should be trimmed or broken without bends or burrs. Burrs and warping of ends are allowed in hot-rolled steel to the extent that they do not result in the profile exceeding the plus tolerance in diameter and thickness. In the case of calibrated steel with special surface finish, those defects should not result in the tolerance in the nominal dimension being exceeded.

Cup formation at the end of the rod caused as a result of straightening on oblique rolling machines does not constitute grounds for rejection.

Gas-cutting is not allowed.

Note: Upto 25 rods out of each "heat" of hot-rolled non-annealed rods

may have ends trimmed by gas-cutting.

2.9 Slope in end trimming of hot-rolled calibrated rods with special surface finish should not exceed:

0.1 of diameter - for rods of diameter upto 30 mm

3 mm - for rods of diameter above 30 mm.

3. Technical Requirements

3.1 Ball Bearing steel should be manufactured in accordance with the requirements of this standard.

3.2 Chemical properties of steel should conform to the norms, indicated in Table 1.

Table 1

Steel grade	Proportion of various elements by weight, %								
	Carbon	Silion	Manganese	Chromium	Sulphur	Phosphorus	Nickel	Copper	Nickel copper
					Not more than				
ШХ15	0.95 1.05	0.17 0.37	0.20 0.40	1.30 1.65	0.02	0.027	0.30	0.25	0.50
ШХ15СГ	0.95 1.05	0.40 0.65	0.90 1.20	1.30 1.65	0.02	0.027	0.30	0.25	0.50
ШХ4	0.95 1.05	0.15 0.30	0.15 0.30	0.35 0.50	0.02	0.027	0.30	0.25	0.50
ШХ20СГ	0.90 1.00	0.55 0.85	1.40 1.70	1.40 1.70	0.02	0.027	0.30	0.25	0.50

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3.2.1. Sulphur content should not exceed 0.01 and phosphorus 0.025% in steel, obtained by electric slag remelting.

Narrow limits are set for steel of grade ШХ15СГ-Ш having cross-section over 140 mm meant for manufacturing large ball-bearings; manganese content - 1.00 to 1.20, chromium content - 1.40 to 1.65 and silicon content - 0.45 to ~~0.65%~~ 0.65%.

3.22 Copper content may go upto 0.30% by maintaining norms of total copper and nickel content not above 0.50% in the case of open hearth steel.

3.3 Hot-rolled steel may be manufactured as annealed or non-annealed. But calibrated steel with special surface finish must be annealed. Calibrated steel with special surface finish should not become cold-hardened as a result of surface machining.

3.4 Roll cracks, laps, roll contaminations, blisters, rolling flaws and tears are not allowed on the surface of hot-rolled rods and strips meant for hot processing and cold stamping.

Surface defects should be rectified. Dressing depth should not exceed: half the tolerance in dimensions reckoned from actual dimension for rods or strips of diameter or thickness less than 80 mm;

tolerance reckoned from actual size for rods of diameter 80 to 180 mm; 5% of nominal size but not more than 15 mm for rods of diameter more than 180 mm.

Width of dressed portions should not be less than five times their depth. Defective portions should not be cut off.

Defects of a mechanical nature (indentation scratches, ripples etc) of depth not exceeding half the tolerance in the depth need not be trimmed.

3.5 Surface defects of depth not exceeding half the tolerance in diameter or thickness reckoned from the actual dimension are allowed on the surface of hot-rolled rods and strips, meant for cold machining (turning, milling etc

3.6 Defects are not allowed on the surface of steel with special surface finish group Б(V). Individual surface defects of a mechanical origin lying not deeper than half the tolerance in diameter are allowed for group Г (G).

Laps, scratches, cracks, oblique trimmings, slag deposits, roll blow holes and contaminations are not allowed on the surface of calibrated rods meant for manufacturing parts by upsetting.

Individual minor scratches, ripples, slag deposits, indentations, oblique trimmings, traces of abrasive trimming not exceeding 1 % of the diameter are allowed on the surface of calibrated rods, meant for manufacturing parts by turning. Depth of defects is reckoned from the nominal size.

3.7 Hot-rolled non-annealed steel of diameter or thickness upto 60 mm inclusive and calibrated steel with special surface finish, meant for forging or stamping should withstand upset test. Hot-rolled steel is tested in hot condition and calibrated steel with special surface finish in cold condition. Noticeable defects should not be present on the upset specimens.

3.8 Annealed hot-rolled, calibrated steel with special surface finish should have hardness as follows:

HB 179 to 207 (indentation diameter 4.5 to 4.2 mm) - for grade ШХ15,

HB 179 to 217 (indentation diameter 4.5 to 4.1 mm) - for grade ШХ15СГ and ШХ20СГ.

3.9 Traces of shrink holes, peeling off, pigeon holes, blisters, flakes and foreign inclusions visible without the use of magnifying devices, should not be present in the macrostructure of ready-made metal (rods, strips and bundles).

General porosity, localised non-uniformity and liquating square not exceeding the norms indicated in Table 2 are allowed.

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Table

Defect	Rod diameter or thickness mm	Maximum permissible number of points steel from		
		Vacuum electric arc, open hearth furnace		Electric slag remelting furnace
		ШХ6, ШХ15, ШХ15СГ	ШХ20СГ	
General porosity	30 and above	2	2	1
Localised non-uniformity	30 to 95 incl.	1.5	2.5	1
	100 and above	2	2.5	1
Liquation square	30 and above	0.5	0.5	Not allowed

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Steel of grade ШХ15 and ШХ15СГ is supplied with strandardised magnitude of defects, determinable in items by magnetic testing method. Inspection methods and norms are set by mutual consent between manufacturer and customer but item nomenclature is left to the customer.

3.10 Fracture of annealed steel should be homogeneous, fine-grained, porcelain like and free from overheating, shrink hole residues and flakes.

3.11 Fracture of hardened steel must be homogeneous, finegrained, porcelain-like and free from overheating, shrink hole residues, flakes or inclusions visible to the naked eye.

3.12 Depth of decarbonised layer (ferrite and transition zone) on either side should not exceed the following values for hot-rolled steel (with or without annealing).

0.40 mm - for steel of diameter or thickness over 15 upto 30 mm
0.50 mm - for steel of diameter or thickness over 30 upto 50 mm
0.60 mm - for steel of diameter or thickness over 50 upto 70 mm
0.85 mm - for steel of diameter or thickness over 70 upto 100 mm
1.10 mm - for steel of diameter or thickness over 100 upto 150 mm.

Rods of diameter or thickness over 150 mm are not checked for decarbonization.

3.13 Depth of decarbonized layer should not exceed 1 % of the rod diameter for calibrated grooved steel.

Decarbonization is not allowed in steelhaving special surface finish.

3.14 Microstructure of hot-rolled annealed steel in rods of diameter or thickness upto and including 85 mm and of calibrated steel with special surface finish should consist of uniformly distributed fine-grained pearlite, not exceeding:

4 points for steel of grade ШХ15, and

5 points for steel of grade ШХ15 and ШХ20СГ

3.15 Carbide lattice is not allowed in the microstructure of annealed steel of diameter or thickness upto and including 60 mm.

Carbide lattice deposit should not exceed 3 points.

3.16 Structural banding and carbide liguation should not exceed the norms specified in Table 3.

3.17 Steel is checked for contamination of non-metallic inclusions by maximum gradation point according to scales 1,2,3 of this standard upto 01.01.1982 and should conform to the norms specified in Table 4.

Table 3

Rod diameter or thickness mm	Type of product	Maximum permissible points			
		Structural Banding		Carbide liguation	
All sizes	Calibrated steel with special surface finish	2	2	1	1
upto 85	Hot-rolled, annealed steel	3	2.5	2	1
upto 140	Hot-rolled, non-annealed steel	4	3	3	2
over 140	-do-	4	3.5	3	2

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Note: These norms are achieved by means of homogening heat-treatment for steel of electric slag remelting process having diameter or thickness 80 mm and more.

Table 4

Melting process	Rod diameter or thickness mm	Type of steel	Group No.	Points as per		
				Oxide	Sulphide	Globul
				Not more than		
Electric arc furnaces with vacuum; Open hearth furnaces	upto 40 incl.	Cold-drawn and hot-rolled annealed	I	2	2	2
		Hot-rolled non-annealed	II	2.5	2.5	2.5
	Over 40 upto 80 incl.	Cold-drawn and hot-rolled annealed	III	2.5	2.5	2.5
		Hot-rolled non-annealed	IV	3	2.5	3
	Over 80	Hot-rolled non-annealed	V	3	3	3
Electric slag remelting	upto 40	-	VI	1	1	1
	over 40	-	VII	1.5	1.5	1.5

Note: Individual excesses (points exceeding the values indicated in Table 4) are allowed for steels of all groups, except the first to the extent given below:

One excess in respect of one of the inclusion types in respect of oxide and sulphide provided it does not exceed half a point for rods of group III.

One excess in respect of two types of inclusions for rods of groups II, IV and V; excess by half a point on one specimen in respect of a single type of inclusion for rods of groups VI and VII.

Besides evaluation by the maximum gradation point, each melt is evaluated by the average gradation point from the maximum evaluation of each specimen in accordance with the norms in Table 5. Evaluation results of each specimen in terms of maximum gradation points and of the melt in terms of average gradation point are given in the accompaning document. Evaluation by average gradation point is optional upto 01.01.1982 and conducted for the sake of date accumulation.

Melting process	Rod diameter or thickness mm	Type of steel	Group No.	Number as per		
				Oxide	Sulphide	Globu
				Not more than		
In electric arc furnaces with vacuum, hearth furnaces	upto 40 incl.	Cold-drawn and hot-rolled, annealed	I	1.75	2	1.5
		Hot-rolled, non-annealed	II	2.25	2.5	2
	over 40 upto 80	Cold-drawn and hot-rolled, annealed	III	2.25	2.5	2
	over 40	Hot-rolled, non-annealed	IV	2.75	3	2.5
Electric slag remelting	upto 40	-	V	1	1	1
	Above 40	-	VI	1.5	1.5	1.5

3.18 Microporosity of steel should not exceed the norms, given in Table 6.

Table 6

Type of product	Rod diameter or thickness, mm	Microporosity in numbers not more than
Calibrated steel with special surface finish	All sizes	Not allowed
Hot-rolled annealed steel	60 and less	-do-
-do-	Above 60 upto 85	2
Electric slag remelting annealed steel	All sizes	Not allowed
Hot-rolled, non-annealed steel	-do-	3

3.19 Calibrated steel with parkerized surface may be manufactured by mutual consent between the manufacturer and the customer.

3.20 If the customer so desires steel is manufactured:

a) to more stringent specifications as to structural banding (maximum gradation point for structural banding being 3 for hot-rolled, non-annealed steel with rod diameter or thickness over 85 to 140 mm);

b) to more stringent specifications as to macrostructure (with gradation points lower than those indicated in Table 2).

c) with high purity in respect of non-metallic inclusions;

d) with hardenability control of rods having diameter or thickness more than 20 mm;

e) with high hardenability achieved for steel IIIX15 with 0.30 to 0.4% of manganese and 1.50 to 1.65% of chromium and for steel IIIX15 OT with 1.05 to 1.20% manganese and 1.5(to 1.65% chromium;

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f) with normalized carbide lattice in rods of thickness or diameter over 60 to 85 mm;

g) with macrostructure control on linear macrotemplates.

Norms as per paras. b,c,f and g are set by mutual consent between the customer and manufacturer.

4. Acceptance Rules

4.1 Steel is accepted in batches. A batch should consist of rods, strips and bundles of the same melt, same size and same mode of heat-treatment. Melting process is indicated in the accompanying document. A batch of electric slag remelted steel should consist of rods, strips and bundles of the same size, same mode of heat-treatment, obtained from electrodes of the same initial melt and remelted by the same process.

4.2 The following scale of sampling is established for quality control of steel:

a) 10% of rods, strips or bundles of a batch for dimensional checks;

b) all rods, strips or bundles of a batch for checking surface quality

c) one specimen per melt for chemical analysis;

d) all rods, strips or bundles of a batch for checking the conformity of steel grade (by sparking or stylscope method, as well as by other non-destructive methods;

e) three rods or bundles of each size in a melt for checking hot and cold upsetting;

f) 1 to 3 rods or strips per ton but not less than 5 to 10 from a batch with diameter or thickness upto 30 mm; and 10% of rods or strips of a batch, but not less than five numbers of a batch with diameter or thickness more than 30 mm; and not less than five bundles of a batch for checking hardness of hot-rolled annealed, calibrated steel with special surface finish.

g) two rods or two bars of a batch for checking microstructure;

h) all rods or bundles of a batch (from one end) for checking for absence in the case of steel with special surface finish, all calibrated sizes and hot-rolled and annealed steel of size upto 50 mm;

two rods of a batch are subjected to inspection of fracture in the case of 100% inspection of calibrated steel by non-destructive testing methods;

i) two rods of a batch for checking fracture of annealed steel of diameter more than 50 mm and non-annealed steel of all diameters on specimens hardened along the fiber;

j) five rods, strips or bundles of a batch for checking the depth of decarbonised layer;

k) five rods, strips or bundles of a batch for checking microstructure (pearlite);

l) five rods, strips or bundles of a batch for each type of inspectio for checking carbide lattice, carbide liquation and structural banding;

m) six rods, strips or bundles of a batch for checking non-metallic inclusions;

n) six rods, strips or bundles of a batch for checking microporosity,

o) two specimens of a melt for checking hardenability.

On nine specimens of steel with special surface finish, calibrated hot-rolled and annealed selected from the accepted rods, strips or bundl. at random;

If the results of repeated inspection are unsatisfactory in respect of nonmetallic inclusions the batch may be broken up into syphons in the case of open melting and each siphon treated as a batch for purposes of inspection; similarly each ingot may be treated as a batch in the case of electric slag steel.

5. Test Procedure

5.1 Sizes of rods, strips and bundles are checked by means of universal measuring devices or templates.

5.2 Sampling for determining chemical composition of steel should be done as per GOST 7565-73, chemical analysis of steel - as per GOST 20560-75, GOST 12344-66, GOST 12345-66, GOST 12347-77, GOST 12348-66, GOST 12350-66, GOST 12352-66, GOST 12355-66 or by other methods providing the necessary accuracy.

5.3 Surface quality is inspected by non-destructive methods: Surface quality may be checked without the use of magnifying devices. Hot-rolled steel is preliminarily subjected to etching or brightening with rings or coils. Distance between rings or coil pitch should not exceed 500 mm.

5.4 Upsetting test should be conducted as per GOST 8817-73. A specimen of height, equal to twice the diameter or twice the thickness of the rod should be set down to 1/3 the initial height by hot upsetting and down to 1/2 the height by cold upsetting.

5.5 Hardness of annealed steel should be checked as per GOST 9012-59 after trimming the decarbonised layer from both ends of selected rods, strips and bundles. Hardness may be checked in the cross-section of specimens.

5.6 Macrostructure should be inspected as per GOST 10243-75 macrostructure of steel of diameter or thickness more than 30 mm should be checked on etched transverse templates and along fracture, but steel of diameter upto 30 mm - only along the fracture.

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Absence of shrink holes may be checked on discs, cut from two ends of a rod or bundle, by the magnetic method.

Macrostructure and shrink hole may be checked by non-destructive testing method as per GOST 12503-75 and GOST 21120-75.

Macrostructure of rods of diameter or thickness above 120 mm is inspected on specimens, reforged to a diameter or thickness of 120 mm;

5.7 A fracture should be obtained by first making a cut on one or both sides and then breaking off the specimen.

5.8 Depth of decarbonized layer should be determined as per GOST 1763-68 The customer plant may conduct preliminary inspection of decarbonization by the sparking method. Specimens are subjected to hardening from a temperature of 850 ± 10°C in oil when checking the depth of decarbonized layer by the method T.

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Hardness should not be less than HRC 61 after trimming the rod surface to a depth corresponding to the permissible norm for decarbonized layer, given in clauses 3.12 and 3.13.

Depth of decarbonized layer of non-annealed steel may be checked along the fracture. If a difference of opinion arises, the depth of decarbonized layer is to be checked by the method M.

5.9 Sampling and preparation of specimens for evaluation of contimination with non-metallic inclusions should be done as per GOST 1778-70. The cut specimens should be subjected to quenching from 850 ± 10°C with cooling in oil and tempering at 150 to 100°C for 1 hour.

Evaluation of contamination with non-metallic inclusions should be done with 90 to 110X magnification and diameter of field of vision 1.1 to 1.3 mm.

Each section is evaluated by comparing its most contaminated spot with scales of this standard.

Needle type oxides are evaluated as per scale No.1, sulphides - as per scale no.2 and un-destorted oxides (globules) - as per scale no.3) Silicates are evaluated as per the scale for needle type oxides or sulphides and are treated as oxide inclusions.

If it is not possible to evaluate the inclusions by one of two adjacent points evaluation is done with intermediate points 0.5, 1.5, 2.5 etc. The arithmetic mean of the maximum evaluations of specimens calculated correct to the first decimal place is taken as the average point.

5.10 Microstructure (pearlite) in hot-rolled annealed and calibrated steel with special surface finish should be checked on transverse specimens. Specimens should be cut in the form of discs of thickness 10 to 25 mm for preparing microsections.

Microsections of steel rods of diameter or thickness upto 40 mm should cover the whole transverse section; and those of rods with diameter or thickness over 40 upto 85 mm must cover one fourth the cross-section. Microsections should be etched in freshly prepared 2 to 4% alcohol solution of nitric acid or in picric acid solution. Pearlite structure should be evaluated by 450 to 500 magnificacion as per scale no.8

5.11 Cutting of specimens, heat-treatment and manufacture of micro-sections for evaluating carbide lattice should be done in the same manner as for evaluation of non-metallic inclusions. Microsections should be etched in 4% nitric acid solution till they become dark and carbides appear clearly.

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Residues of carbide lattice should be evaluated by 450 to 500 X magnifications over the worst spot of microstructure by comparison with standard scale no.4

A batch of metal should be evaluated on the basis of the maximum gradation point from among the evaluations of different specimens.

The central zone of diameter 25 mm need not be checked in the case of steel of diameter or thickness 61 to 85 mm while despatching steel with normalized carbide lattice.

5.12 Structural banding should be evaluated on longitudinal crosssection

Cutting, heat-treatment and manufacture of microsections should be done in the same manner as for evaluation of non-metallic inclusions. Specimens, selected from non-annealed steel, should be preliminarily annealed for hardness, corresponding to clause 3.8. Specimens, cut from rods of diameter 140 mm and more are subjected to heat-treatment without preliminary annealing.

Microsections should be etched in a freshly prepared 4% nitric acid solution in alcohol. Etching time is 15 to 20 seconds.

Structural banding should be evaluated by 90 to 110 magnification by comparison with master specimen scale no.5 of this standard. The maximum structural banding should be evaluated on each microsection.

If it is not possible to conduct evaluation of structural banding by comparison with one of two adjacent specimens evaluation may be done with intermediate points 0.5, 1.5, 2.5, 3.5 etc.

Maximum point from the specimen evaluations is taken as the inspect result.

5.13 Cutting of specimens, their heat-treatment and preparation of microsections for evaluating carbide liquation should be done in the same manner as for evaluation of non-metallic inclusions. Carbide liquation should be evaluated with 90 to 110 magnification over the worst spot by

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comparison with master specimen scale no.6 of this standard.

The batch of metal should be evaluated on the basis of the highest point among the specimens.

5.14 Microporosity should be evaluated by examining specimens, manufactured for checking non-metallic inclusions.

Maximum microporosity, which is evaluated in points by comparison with master specimen scale no.7 of this standard, is determined on each microstructure with 90 to 110 magnification.

If it is not possible to evaluate microporosity by one of two adjacent points it may be evaluated using the intermediate points 0.5, 1.5, 2.5 and 3.5. Microporosity in electroslag steel should be checked only in the profile to be supplied.

The highest point from the specimen evaluations is taken as the result of inspection.

5.15 Rods of diameter or thickness 28 mm and more are subjected to hardenability check. Inspection is done by surface quenching method as per GOST 5657-60 and the method given in mandatory annexure no.2. Rods of cross-section 50 mm and more should be reforged or re-rolled in the original direction of fibre into a testpiece of diameter or thickness 30 mm approximately.

5.16 Structural banding, carbide liquation and carbide lattice may be evaluated on specimens, manufactured for inspection of non-metallic inclusions.

5.17 When several profile sizes are made from electroslag steel, macrostructure, non-metallic inclusions, microporosity (steel from open hearth melting), structural banding and carbide liquation may be checked in the profile of maximum size and the inspection results taken as applic to all the smaller sizes.

6. Marking and Packing

6.1 Marking, packing and formulation of documentation should conform to the requirements of GOST 7566-69 with the following additional stipulations.

6.11 All rods of diameter or thickness 30 to 70 mm inclusive should be marked on the edge and rods of diameter or thickness more than 70 mm - on the surface.

Note: Rods of diameter or thickness 70 mm and more may be marked by gluing paper tags coated with moisture proof varnish by mutual consent between the manufacturer and the customer.

6.12 Marking of bundles and rods having diameter or thickness less than 30 mm should be applied on tags attached to each bundle. Marking should be done with green paint on atleast three control rods in a bundle by painting their ends.

6.1.3 Steel produced by electric slag remelting process, should have additional marking with the letter " Ш " without the dash which is written in the accompanying documentation, e.g Ш Х15 - Ш Ш

6.1.4 Steel with special surface finish should be packed in sack cloth, synthetic film or boxes with paper packing. Other types of packing which ensure the preservation of steel from damage and corrosion during transport are permitted.

6.2 Calibrated steel with special surface finish should be coated lightly with removable grease for preservation from corrosion, if the customer agrees.

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ANNEXURE 1

Mandatory

Additional diameters of calibrated rods made of ball bearing steel.

5.4; 5.7; 6.2; 6.6; 7.2; 7.6; 7.9; 8.1; 8.3; 8.4; 8.6; 8.7; 9.1; 9.4; 9.6; 9.7; 10.1; 10.3; 10.4; 10.7; 10.9; 11.3; 11.4; 11.6; 11.7; 11.9; 12.1; 12.3; 12.4; 12.6; 12.7; 12.9; 13.3; 13.4; 13.6; 14.1; 14.3; 14.4; 14.6; 14.7; 14.9; 15.4; 16.3; 16.6; 16-7; 17.3; 17.4; 17.9; 18.2; 18.3; 13.4; 18.8; 19.1; 19.2; 19.2; 19.3; 19.8; 20.2; 20.4; 20.6; 20.8; 21.4; 21.6; 21.7; 21.3; 22.5; 22.8; 22.9; 23.2; 23.5; 23.8; 24.2; 24.5; 24.8; 25.5; 26.2; 27.5; 28.5 mm

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ANNEXURE 2

Mandatory

Inspection of hardenability of steel grades WX15 and WX15 CT by the surface quenching method

Hardenability of steel is tested by the surface quenching method by heating one end of a cylindrical specimen upto the quenching point and cooling it with water in a special device. After quenching, hardness is measured along the length of the specimen from the surface cooled with water to the unquenched head. Depth of hardenability is determined by interpolation.

Penetration depth of quenched zone from the surface being cooled to the point having hardness HRC 61, is taken as the hardenability of steel of grade WX15 and WX15CT (drg.1)

1. Selection of specimens

1.1 The specimen for testing hardenability of steel should be of cylindrical shape having diameter 25 ± 0.25 mm and length 100 ± 0.5 mm with a collar at on one end (drg.1)

1.2 The specimen is turned from a rod of cross-section 28 to 50 mm in accordance with the requirements of GOST 7564-73. In the case of rods having cross-section 50 mm or more a square of side 30^{+10}_{-2} mm is

Черт. 1. Fig.1

milled from a forged or re-rolled sample into rounds. The axis of the specimen should coincide with that of the rod.

1.3 Specimens are turned from annealed steel. The structure of steel after annealing should conform to the requirements of this standard. Pearlite point is indicated in the test report.

1.4 The melt and specimen numbers should be marked on the collar.

1.5 Two specimens are selected from each melt for checking hardenability.

2. Equipment and Devices

Furnace for heating specimens to be quenched.

Specimens to be quenched are heated in an electric chamber furnace with a temperature differential not more than ± 4°C across the operating space and not more than ± 3°C in time. The necessary level of stability in temperature is maintained in the following manner:

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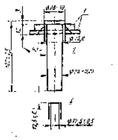
Установка для закалки образца (черт. 2)

Installation for hardening the specimen (drg. 2)



1—держатель; 2—образец; 3—сопло

Черт. 2

Drg. 2

1-holder; 2-specimen; 3-nozzle

Working space of furnace is separated from the heating space by a special metallic screen muffle (eg. made of steel of grade X23 H18);

Temperature in the furnace is maintained at the given level by a platinum - platinum - rhodium thermocouple with an adjustable potentiometer. Furnace control is accomplished by a three position switch "maximum", "normal" and "off". The thermocouple for controlling the operation in the furnace should have an additional hole for installing a thermocouple control which is connected to a portable potentiometer type ПП . The reading accuracy of thermocouple operation in the operating period should be checkd daily with a control thermocouple having a portable potentiometer of type ПП .

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The installation should confirm to the following basic requirements:

The specimen should be fixed vertically with the end surface placed over the nozzle and the axis of specimen aligned with that of the nozzle. Diameter of nozzle 12.5 ± 0.5 mm height of free water jet over the nozzle 65 ± 5 mm and distance from nozzle to specimen end 12.5 ± 0.5 mm; Before setting the specimen, the jet should be covered with a special

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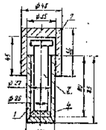
3.1. Время нагрева образца (с момента посадки в печь) должно быть 40 мин. Образцы помещают в предварительно нагретые при 850°С в течение 30 мин стаканчики.



1 – корпус; 2 – крышка; 3 – образец; 4 – графитовая пластина

1-case; 2-cover; 3-specimen; 4-graphite plate.

Черт. 3 Fig.3

plate, which can be turned to one side after the heated specimen is placed in position. Jet height should be constant during the cooling process;

Water should touch only the specimen edge, without washing its cylindrical surface.

Device for measuring hardness.

Rockwell hardness (HRC) is determined as per GOST 9013-59. Hardness of different steel batches should be measured on one and the same hardness gauge and diamond cone. The device should be tuned for measuring hardness in the range of HRC 60 to 65.

3. Preparation of Specimens

3.1 The water-cooled end of the specimen, should be protected from oxidation and decarbonization while it is being heated. The specimen is placed in a cylindrical steel can fitted with a lid. The specimen is laid on a graphite plate or on a layer of refined graphite, the end meant to be cooled being in contact with the graphite. The design and size of can are given in drg.3.

3.2 Not more than two specimens in cans, corresponding exactly to the design shown above should be heated simultaneously in a furnace. Cans should be laid in the center of the furnace over a ceramic base (brick) such, that thermocouple ends are at a distance of not more than 10 mm from the can (or between cans, if they have two).

3.3 The temperature should be set at 850°C for steel of grade 10 HX15 and 840°C for grade HX150f. Page 18 GOST 801-78

3.4 Duration of heating (from the moment of placement in the furnace) should be 60 minutes. Specimens are placed in cans preliminarily heated at 850°C for 30 minutes.

3.5 The duration from the moment of removing the specimen from the furnace upto the starting of cooling should not exceed 5 seconds.

3.6 The door should be immediately closed after removing the specimen.

3.7 Specimens should be under the water jets till they are completely cooled (not less than 10 minutes).

3.8 Temperature of the cooling water should be 10 to 20°C. The actual temperature of cooling water should be indicated in the test certificate if it has not been possible to mention it within the indicated limits during the test.

4. Hardness measurement

4.1 Two diametrically opposite and exactly parallel surfaces are ground to a depth 0.7 ± 0.1 mm for measuring hardness along the entire length of the quenched specimen.

4.2 The surface should be ground with abundant cooling water or special emulsions on a grinding machine. Surface roughness should correspond to GOST 2789-73 and surface roughness to class 7 category C.

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Burns causing structural change in metal are not allowed. Polishing the track manually by emergy cloth is not allowed.

Note: 1. Scorching may be exposed on the specimen surfaces after polishing as follows:

The polished surface is washed with (hot) water and etched in 5% nitric acid aqueous solution (as per GOST 4461-77), until the surface becomes black (30-50 seconds).

After etching, the surface is washed with 50% hydrochloric acid aqueous solution for 3 seconds (as per GOST 3118-77) and washed with water. Variations in hardness and structures occuring during polishing after the above treatment, appear in the form of light and dark spots.

2. Scorching caused during polishing, should be removed by repeated polishing to a depth of 0.1 mm before measuring hardness.

3. Emulsion traces must be removed from the specimens before measuring hardness by washing with benzene or alcohol.

4. Traces left by the first measurement should be removed before measuring the hardness on the opposite surface. Burrs from pickings are removed with emery paper no.3 or micron no.40.

4.3 Measurement of hardness for determining the hardenability of steel is started at a distance of 1.1 mm from the quenched edge in the axial direction and repeated every 1.5 mm till a hardness less than HRC 61 for steel of grade 11X15 and less than HRC 60 for steel of grade X15C is encountered. Place of hardness measurement should be marked on the polished surface with the help of a special device or a pencil using a metallic scale.

4. If it becomes necessary to measure hardness a second time, the surface on which measurement was carried out must be polished. Depth of metal removal during repeated polishing should be 0.1 to 0.2 mm.

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A fresh track may be made.

4.5 Specimens are rejected if there are cracks or other defects in them leading to distortion of results of hardness measurement.

5. Evaluation of test results

5.1 The arithmetic mean of harness values is calculated for each pair of points equidistant from the edge but on two opposite surfaces.

5.2 Distance from specimen edge is determined by interpolation method upto the point, having hardness HRC 61 for steel of grade ШХ15 and HRC 50 for steel of grade ШХ15СГ. For example, at a distance of 7.5 mm from the specimen edge, average hardness of steel of grade ШХ15 by measurement from both sides is HRC 63.5, and at a distance of 9.0 mm - HRC 59.0

1. Difference in hardness at these adjacement points:

HRC 63-5-HRC 59.0 = HRC 4.5

2. Difference in hardness at a point 7.5 mm from the edge (above critical) with critical hardness:

HRC 63.5 - HRC 61.0 = HRC 2.5

3. Hardness drop by HRC 4.5 occurs over a length of 1.5 mm.

4. Hardness drop by HRC 2.5 occurs over a length equal to

$$\frac{2.5 \times 1.5}{4.5} = 0.83 \text{ mm}$$

5. Hardenability of the given specimen is:

7.5 + 0.83 = 8.33 mm.

A similar result would have been obtained in calculating the position of the point with depth of hardenability HRC 61.0, if it was carried out

from the point having hardenability less than the critical value.

In this case the calculated distance corresponding to the hardness gradient is not added but deducted. Calculation for the example given above would then have taken the form:

HRC 61.0 – HRC 59.0 = HRC 2.0

Черт. 4
Fig.4

$$2 \times \frac{1.5}{4.5} = 0.668 = 0.33 \text{ m}$$

= 9.0 mm – 0.67 mm = 8.33 mm

In the same manner hardenability may be determined by interpolation graphically also. A typical graph for calculation is shown in drg.4 and requires no special explanation.

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(29)

BASE SI UNITS

Quantity	Unit		
	Name	Russian symbol	International symbol
Length	metre	м	m
Weight (Mass)	Kilogram	кг	kg
Time	second	с	s
Current	ampere	А	A
Thermodynamic temperature	kelvin	К	K
Amount of substance	mole	моль	mol
Intensity of light	candela	кд	cd
SUPPLEMENTRY SI UNITS			
Plane angle	radian	рад	rad
Solid angle	steradian	ср	sr

DERIVED SI UNITS WITH PROPRIETORY NAMES

Quantity	Unit		Expression for derived unit	
	Name	Symbol	using other units	using base SI units
Frequency	hertz	Hz	-	s^{-1}
Force	newton	N	-	$m.kg.s^{-2}$
Pressure	pascal	Pa	N/m^2	$m^{-1}.kg.s^{-2}$
Energy, work, heat	joule	J	N.m	$m^2.kg.s^{-2}$
Power, energy, flow	watt	W	J/c	$m^2.kg.s^{-3}$
Quantity of electricity, electric charge	coulomb	C	A.s	s.A
Electric potential	volt	V	W/A	$m^2.kg.s^{-3}.A^{-1}$
Electric capacitance	farad	F	c/V	$m^{-2}.kg^{-1}.s^4.A^2$
Electric resistance	ohm		V/A	$m^2.kg.s^{-3}.A^{-2}$
Conductance	siemens	S	A/V	$m^{-2}.kg^{-1}.s^3.A^2$
Magnetic flux	weber	Wb	V.s	$m^2.kg.s^{-2}.A^{-1}$
Magnetic induction	tesla	T	Wb/m^2	$kg.s^{-2}.A^{-1}$
Inductance	henry	H	Wb/A	$m^2.kg.s^{-2}.A^{-2}$
Luminous flux	lumen	lm	-	cd.sr. *
Illumination	lux	lx	-	$m^{-2}.cd.sr.$ *
Nucleid activity	becquerel	bk	-	s^{-1}
Radiation dosage	grey	gr	-	$m^2.s^{-2}$

* The supplementary unit steradian figures along with base SI units in these two expressions.