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Steel Forgings
Machining Allowances and Permissible Variations for Open-die Forged Bars

DIN 7527 Part 6

Schmiedestücke aus Stahl;
Bearbeitungszugaben und zulässige Abweichungen
für freiformgeschmiedete Stäbe

Dimensions in mm

1. Scope

This Standard applies to open-die forged bars which have had their final shape imparted to them by hammers or presses.

It applies to round, square, hexagonal and octagonal bars, as well as to flat bars of high-grade steel including tool steel and high speed steel with a width-to-thickness ratio smaller than or equal to 8 : 1, and also to flat bars of ordinary low carbon steel and quality steel having a width-to-thickness ratio smaller than or equal to 5 : 1.

It applies to bars up to a maximum finished dimension of 1000 mm in thickness or width and 6000 mm in length.

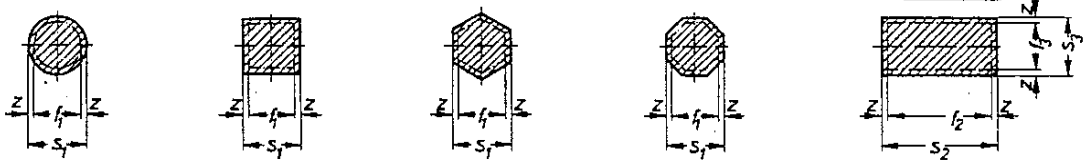
2. Dimensions and cross-sectional shapes

2.1. Dimensions

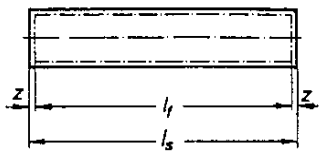
The dimensions of open-die forged bars are thickness, width and length. In the case of round bars the diameter counts as the thickness, whilst in the case of square, hexagonal and octagonal bars the thickness is taken as the distance between the parallel side faces. In the case of flat bars the thickness is taken as the smaller distance and the width as the larger distance between the parallel side faces.

2.2. Cross-sectional shapes

A	B	C	D	E
Round bar	Square bar	Hexagonal bar	Octagonal bar	Flat bar



Length for all cross-sectional shapes



f_1, f_2, f_3, l_f = finished dimensions
s_1, s_2, s_3, l_s = forging dimensions
z = machining allowance

3. Machining allowances and permissible variations

3.1. Machining allowances and permissible dimension variations

These are given in Table 1.

Except for the thickness of flat bars, the criteria for determining machining allowances and permissible variations for lengths and cross-sectional dimensions are the nominal dimensions concerned.

Machining allowances and permissible variations for the thickness of flat bars are to be calculated on the basis of a reference dimension derived from half the sum of "width plus thickness" (arithmetic mean). The reference dimension calculated in this way is to be equated with f_1 or f_2 or with s_1 or s_2 in Table 1, depending on whether the machining allowance and permissible variations are derived from the finished dimensions or the forging dimensions.

$$\frac{f_2 + f_3}{2} \triangleq f_1 \text{ or } f_2 \text{ or } \frac{s_2 + s_3}{2} \triangleq s_1 \text{ or } s_2 \text{ in Table 1}$$

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3.2. Variations from cross-sectional shape

The permissible dimension variations on the thickness of round, square, hexagonal and octagonal bars and on the thickness and width of flat bars include variations of shape, in other words the bar cross-sections may depart from the geometrical shape within the limits of the permissible dimension variations.

4. Finish

4.1. Condition of bar ends

At the manufacturer's choice, open-die forged bars are supplied with sawn, guillotined, flame-cut or hammer-parted ends. If the purchaser requires a specific type of ends, he must expressly specify this in the order.

4.2. Surface condition

Surface defects (e. g. scale marks, decarburization, forging laps, cracks) may occur within the limits of the machining allowances; they may be removed by suitable methods, provided that this does not impair the use of the bars.

5. Material and heat treatment

The material is to be clearly specified by means of the material code number or the material number in accordance with the relevant material standards, and the type of heat treatment similarly according to DIN 17014.

6. Methods of ordering

6.1. Cross-sectional data

6.1.1. Orders based on finished dimensions

For the thickness or thickness and width, the purchaser quotes the dimensions which the bar is required to have after final machining.

From Table 1, the manufacturer determines the machining allowances, calculates the forging dimensions (see Section 7) and, observing the permissible variations according to Table 1, supplies a bar which is thicker than the ordered size by the extent of the machining allowances.

When bars are premachined prior to heat treatment, the premachining dimensions count as finished dimensions.

6.1.2. Orders based on forging dimensions

The purchaser quotes the forging dimensions calculated from the finished dimensions and the machining allowances according to Table 1.

The manufacturer, observing the permissible variations according to Table 1, supplies a bar with the dimensions stated in the order.

For distinguishing from orders based on finished dimensions, orders based on forging dimensions are to have the letter S (forging dimension) appended to the letters denoting the cross-sectional shape (A, B, C, D or E). If an order based on forging dimensions omits the letter S, it will be treated in the same way as an order based on finished dimensions (see Section 6.1.1), and a bar will be supplied which, compared with the dimensions stated in the order, is thicker, or thicker and wider, by the extent of the machining allowances.

6.2. Length data

6.2.1. Orders based on finished dimensions

The purchaser indicates the length of the bar after final machining.

From Table 1, the manufacturer determines the machining allowances, calculates the forging dimension (see Section 7) and, observing the permissible variations according to Table 1, supplies a bar which is longer than the ordered dimensions by the extent of the machining allowances.

If, for the purpose of joint ordering, the finished lengths of two or more bars plus allowances for the necessary number of parting cuts are combined to form a total length, this length is treated as a finished dimension.

6.2.2. Ordering in forging dimensions

The purchaser states the forging dimensions calculated from the finished dimensions and the machining allowances according to Table 1.

The manufacturer, observing the permissible variations according to Table 1, supplies a bar of the length ordered.

6.2.3. Ordering in manufacturing lengths

Instead of quoting a figure for the length, the purchaser writes in the word "manufacturing lengths" (Herstellängen) or the abbreviation "Hstlg.".

The manufacturer, observing the permissible variations according to Table 1 on thickness or thickness and width, supplies bars to his own choice in lengths conforming to normal practice and ranging up to a maximum length of 6000 mm.

6.2.4. Ordering in a length range

The purchaser states the lower and upper limiting size of the required length range by quoting "from...to...".

The manufacturer, observing the permissible variations according to Table 1 on thickness or

thickness and width, supplies bars in lengths lying within the range stated.

It is not permissible to state length ranges extending simultaneously both above and below a length of 3500 mm, since according to Table 1 different machining allowances and permissible variations apply to thickness or thickness and width in the case of lengths up to 3500 mm and lengths over 3500 and up to 6000 mm.

7. Examples for calculating forging dimensions

7.1. Round bar A 165 x 2020 DIN 7527 - St 37-3

Machining allowances and permissible variations

on thickness f_1 = 165 mm 18 and $\pm$ 4.9 mm

on length l_f = 2020 mm 22 and $\pm \frac{20}{13}$ mm

forging dimensions s_1 = 165 + 18 = (183 $\pm$ 4.9) mm

l_s = 2020 + 22 = (2042 $\pm \frac{20}{13}$) mm

7.2. Flat bar E 165 x 60 x 4500 DIN 7527 - C 45

Machining allowances and permissible variations

on width f_2 = 165 mm 21 and $\pm$ 6.3 mm

on length l_f = 4500 mm 26 and $\pm \frac{22}{15}$ mm

forging dimensions s_2 = 165 + 21 = (186 $\pm$ 6.3) mm

l_s = 4500 + 26 = (4526 $\pm \frac{22}{15}$) mm

Calculation of the reference dimension: $\frac{165 + 60}{2}$ = 112.5 mm

Machining allowances and permissible variations according to the reference dimension 112.5 mm

on thickness f_3 = 60 mm 17 and $\pm$ 4.8 mm

forging dimension s_3 = 60 + 17 = (77 $\pm$ 4.8) mm

8. Examples of orders

8.1. Ordering thickness and length based on finished dimensions

Ordering 10 open-die forged round bars (A) for a finish machined thickness of 165 mm and a finish machined length of 2020 mm in St 37-3:

10 bars A 165 x 2020 DIN 7527 - St 37-3

8.2. Ordering thickness based on finished dimensions and length in a particular length range

Ordering 5 open-die forged square bars (B) for a finish machined thickness of 260 mm in steel according to material No. 1.0727.02 in lengths of 4000 to 5000 mm:

5 bars B 260 x 4000 to 5000 DIN 7527 - 1.0727.02

8.3. Ordering thickness and length based on forging dimensions

Ordering 12 open-die forged round bars (A) according to forging dimensions (S) of 160 mm thickness and 320 mm length in C 45, soft annealed (G):

12 bars AS 160 x 3200 DIN 7527 - C 45 G

8.4. Ordering thickness based on forging dimensions and length in manufacturing lengths

Ordering 8 open-die forged square bars (B) according to forging dimensions (S) of 180 mm thickness in steel according to material No. 1.0116, in manufacturing lengths:

8 bars BS 180 DIN 7527 - 1.0116 in manufacturing lengths

Explanations

This Standard is the outcome of discussions between manufacturers and users of open-die forged bars.

In response to wishes expressed by users, the scope of the Standard has been extended to include a maximum finished dimension of 1000 mm for the thickness of round, square, hexagonal and octagonal bars, and for the width of flat bars.

Hitherto it has only been possible to order open-die forged bars on the basis of their finish machined dimensions. This Standard provides a second method of ordering for use in cases when, for example, bars are to be ordered for stock and their finish machined dimensions are not known, or machining of the surface is not intended (e. g. bars for unfinished hexagon nuts).

Whilst small machining allowances and small permissible variations involve smaller amounts of material usage, they demand in return increased cost on the forging side. In this Standard the machining allowances and permissible variations have been chosen in such a way that the cost of the finished part is near the economic optimum. Since the cost in terms of material usage depends on the quality of the steel grades concerned, these have been associated with different machining allowances and permissible variations.

In conformity with the definition of machining allowances commonly accepted in practice as being allowances per area, the Figure showing the different cross-sectional shapes indicates the dimension letter changed from the former z/2 to z and, correspondingly in the Table, from z, as formerly, to 2 z.

The previous indication of the cross-sectional shapes by letters A, B, C, D and E has been retained.

The denomination of the steel groups in the Table has been brought into agreement with DIN 17007; the corresponding ranges of material numbers have been quoted.

The Table has been enlarged by including nominal dimension ranges for forging dimensions. In addition, particulars regarding variations of shape and surface condition as well as a note on heat treatment have been included in the Standard.

Table 1. Machining allowances and permissible variations

Finished dimension f_1 or f_2		Tool steels and high speed steels, Material No. 1.1500 to 1.1899, 1.2000 to 1.3399												High-grade steels (except tool steels and high speed steels), Material No. 1.1100 to 1.1299, 1.1300 to 1.1399, 1.1400 to 1.1499, 1.1500 to 1.1599												Ordinary low carbon steels and quality steels, Material No. 1.0000 to 1.0299, 1.0300 to 1.0799, 1.0800 to 1.0999											
		Bar length l_f up to 3500						over 3500 to 6000						Bar length l_f up to 3500						over 3500 to 6000						Bar length l_f up to 3500						over 3500 to 6000					
		Cross-section		Length		Forging dimension s_1 or s_2		Cross-section		Length		Forging dimension s_1 or s_2		Cross-section		Length		Forging dimension s_1 or s_2		Cross-section		Length		Forging dimension s_1 or s_2		Cross-section		Length		Forging dimension s_1 or s_2		Cross-section		Length		Forging dimension s_1 or s_2	
over	up to	Allowance 2z	perm. var.	Allowance 2z	perm. var.	over	up to	Allowance 2z	perm. var.	Allowance 2z	perm. var.	over	up to	Allowance 2z	perm. var.	Allowance 2z	perm. var.	over	up to	Allowance 2z	perm. var.	Allowance 2z	perm. var.	over	up to	Allowance 2z	perm. var.	Allowance 2z	perm. var.	over	up to	Allowance 2z	perm. var.	Allowance 2z	perm. var.	over	up to
16	25	2,6	± 0,6	9	+10 −7	18,6	27,6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25	40	3	± 0,7	9	+10 −8	28	43	–	–	–	–	–	–	5	± 0,9	11	+10 −8	30	45	8	± 2,6	16	+14 −9	33	48	–	–	–	–	–	–	–	–	–	–	–	–
40	63	4	± 0,9	10	+11 −8	44	67	6	± 1,4	14	+11 −9	46	69	6	± 1,1	12	+11 −8	46	69	9	± 2,9	17	+14 −10	49	72	9	± 2,8	13	+13 −9	49	72	–	–	–	–	–	–
63	80	5	± 1,1	11	+12 −9	68	85	7	± 1,6	15	+12 −10	70	87	7	± 1,4	14	+12 −9	70	87	11	± 3,3	18	+15 −11	74	91	11	± 3,1	15	+14 −9	74	91	14	± 4	20	+18 −12	77	94
80	100	6	± 1,3	12	+13 −9	86	106	8	± 1,9	16	+13 −10	88	108	8	± 1,7	15	+13 −9	88	108	12	± 3,6	20	+17 −11	92	112	12	± 3,4	16	+16 −10	92	112	15	± 4,4	21	+20 −12	95	115
100	125	7	± 1,5	14	+14 −11	107	132	10	± 2,1	17	+14 −10	110	135	10	± 2	16	+14 −11	110	135	13	± 4	21	+18 −12	113	138	14	± 3,8	17	+17 −10	114	139	17	± 4,8	22	+21 −13	117	142
125	160	9	± 1,8	15	+14 −11	134	169	12	± 2,5	19	+15 −12	137	172	12	± 2,3	18	+14 −11	137	172	15	± 4,6	22	+20 −13	140	175	16	± 4,2	19	+18 −11	141	176	19	± 5,4	24	+22 −14	144	179
160	200	11	± 2,2	17	+14 −14	171	211	14	± 2,9	21	+16 −14	174	214	14	± 2,8	20	+14 −14	174	214	18	± 5,2	25	+22 −14	178	218	18	± 4,9	22	+20 −13	178	218	21	± 6,3	26	+22 −15	181	221
200	250	13	± 2,6	20	+16 −16	213	263	17	± 3,5	23	+17 −17	217	267	17	± 3,4	23	+16 −16	217	267	21	± 6	27	+24 −16	221	271	21	± 5,6	24	+22 −14	221	271	24	± 7,2	29	+26 −17	224	274
250	315	16	± 3,2	23	+18 −18	266	331	21	± 4,2	26	+19 −19	271	336	21	± 4,2	26	+18 −18	271	336	24	± 7	30	+27 −18	274	339	25	± 6,5	28	+26 −15	275	340	28	± 8,4	32	+29 −19	278	343
315	400	19	± 4	27	+21 −21	334	419	26	± 5	30	+22 −22	341	426	26	± 5,1	30	+21 −21	341	426	29	± 8,4	35	+31 −20	344	429	30	± 7,7	32	+28 −18	345	430	33	± 10	36	+33 −22	348	433
400	500	24	± 4,9	32	+25 −25	424	524	32	± 6,2	35	+26 −26	432	532	32	± 6,3	36	+25 −25	432	532	35	± 10	40	+35 −24	435	535	36	± 9,2	38	+33 −22	436	536	40	± 11,9	42	+38 −25	440	540
500	630	30	± 6	38	+29 −29	530	660	39	± 7,5	41	+31 −31	539	669	39	± 7,8	42	+29 −29	539	669	42	± 12	47	+42 −28	542	672	44	± 11	45	+39 −25	544	674	48	± 14,3	49	+46 −29	548	678
630	800	37	± 7,4	47	+35 −35	667	837	49	± 9,4	49	+36 −36	679	849	49	± 9,8	52	+35 −35	679	849	52	± 14,9	55	+49 −33	682	852	54	± 13,5	55	+45 −30	684	854	58	± 17,4	58	+51 −34	688	858
800	1000	46	± 9,3	57	+42 −42	846	1046	61	± 11,6	53	+44 −44	861	1061	61	± 12,1	63	+42 −42	861	1061	64	± 18,1	66	+59 −40	864	1064	66	± 16,3	67	+55 −36	866	1066	71	± 21,3	69	+61 −41	871	1071

For bars with finished dimensions over 16 and up to 25, the stated values apply only to bar lengths up to 2000 mm.

The determination of allowances and permissible variations for the thickness of flat bars is effected by using a reference dimension corresponding to half the sum of the width plus thickness. The values in the Table apply to flat bars only with a width-to-thickness ratio ≦8 : 1 in the case of high-grade steels including tool steels and high speed steels, and ≦5 : 1 in the case of ordinary low carbon steels and quality steels.