BS EN 847-1:2013

BSI Standards Publication

Tools for woodworking — Safety requirements

Part 1: Milling tools, circular saw blades

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National foreword

This British Standard is the UK implementation of EN 847-1:2013. It supersedes BS EN 847-1:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MTE/23, Woodworking machines.

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

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 847-1:2013) has been prepared by Technical Committee CEN/TC 142 “Woodworking machines - Safety”, the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by April 2014, and conflicting national standards shall be withdrawn at the latest by April 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 847-1:2005+A1:2007.

The following table contains a list of modifications from the previous edition.

EN 847-1:2005+A1:2007	EN 847-1:2013	Reason
3 Terms	3 Terms and definitions	editorial (ed)
4 Symbols and abbreviations	3.2 Symbols and abbreviations	ed
5 List of significant hazards	4 List of significant hazards	ed
6 Design requirements	5 Design requirements	ed
6.2.3.2.2 Balance quality requirements	5.2.3.2 Balance quality requirements	ed
Table 4 (5): 3 columns	Table 5: 4 columns	Precision of requirements (te)
	New Table 6: Quantities and units	ed
7 Tool identification	6 Tool identification	ed
8 Information for use	7 Information for use	ed
Annex A: Safe work practice	7.2 Safe working practice	ed
Annex B: Maintenance and modification of milling tools and related components	Annex A: Maintenance and modification of milling tools and related components	ed
Annex C: Palmqvist toughness test	Annex B: Palmqvist toughness test	ed

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The extent to which hazards are covered is indicated in the Scope of this document.

The requirements of this document concern designers, manufacturers, suppliers and importers of tools for woodworking.

This document also includes information which the manufacturer will provide to the user.

1 Scope

This European Standard specifies all hazards arising from the use of tools for woodworking machines, and describes the methods for the elimination or reduction of these hazards by tool design and by the provision of information. This European Standard deals with milling tools (bore mounted, shank mounted), integrated tools and circular saw blades.

This European Standard does not cover any hazard related to the strength of shank of shank mounted milling tools. The hazards are listed in Clause 4. This European Standard does not apply to boring bits, eccentric single router cutters, cutters with cutting circle less than 16 mm and to tools used in rotary knife lathes and copying lathes where the hazard of ejection and contact with the tool is always prevented by a system of fixed guards and/or movable guards interlocked with guard-locking and/or self-closing guards.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 847-2, *Tools for woodworking — Safety requirements — Part 2: Requirements for the shank of shank mounted milling*

EN 23878, *Hardmetals — Vickers hardness test (ISO 3878)*

ISO 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 1940-1, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
milling tools
rotating cutting tool (e.g. milling cutter, planing cutter, thicknessing cutter) normally having its main feed direction perpendicular to the rotation axis, for working various surfaces on wood and similar materials through chip removal

Note 1 to entry: The cutting edge of the cutting part may be

- parallel to the axis of rotation,
- square to the axis of rotation, or
- a profile which is a combination of the two.

The tool may be

- a one piece tool,
- a composite tool,

— a complex tool, or

— in the form of a tool set.

3.1.2
circular saw blade
rotating cutting tool for cross-cutting or ripping wood and similar materials through chip removal

Note 1 to entry: The tools cut on the periphery and on both flanks simultaneously, and may be

— a one piece tool,

— a composite tool, or

— a complex tool.

3.1.3
one piece tool (solid tool)
tools without bonded or detachable parts: the body and the cutting parts are one piece

3.1.4
composite tool (tipped tool)
tools where the cutting parts (tips) are firmly connected by bonding to the body, e.g. welding, brazing, adhesive fixing

3.1.5
complex tool
tools where one or more cutting parts (inserts, blades) are exchangeably mounted in a body through detachable fixing elements

Note 1 to entry: The cutting parts may be one piece or composite.

3.1.6
tool set
number of individual tools clamped together on a tool carrier designed to function as one tool

3.1.7
integrated tools
tools where the body is part of the machine and only the cutting parts are exchangeable

3.1.8
body
part of the tool which holds the cutting blades or inserts, or on which the cutting parts are formed

[SOURCE: ISO 3002-1:1982, 3.2.1]

3.1.9
cutting part
functional part or parts of the tool each comprised of chip producing elements

Note 1 to entry: The cutting edges, face and flank are therefore elements of the cutting part. In the case of a multi-toothed cutter, each tooth has a cutting part.

[SOURCE: ISO 3002-1:1982, 3.2.5]

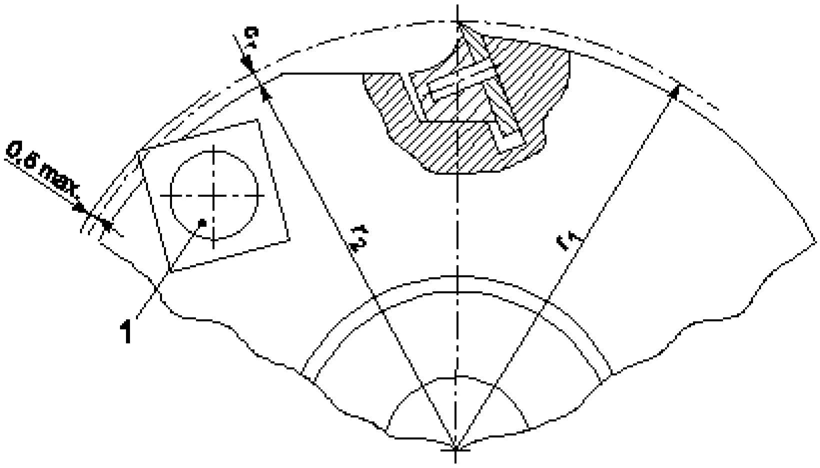
3.1.10
auxiliary cutting parts
auxiliary cutting parts are additional cutting parts with a cutting width of less than or equal to 12 mm and a radial cutting edge projection to the body of less than or equal to 13 mm

EXAMPLE Grooving inserts, bevelling inserts, chamfering inserts.

3.1.11
spur
cutting part which operates both on its periphery and on its flank

Note 1 to entry: The spur projects from the major cutting edge in radial, and if applicable, in axial direction. A spur is either a separate cutting part (see Figure 1) or a part of the major cutting edge.

Dimensions in millimetres



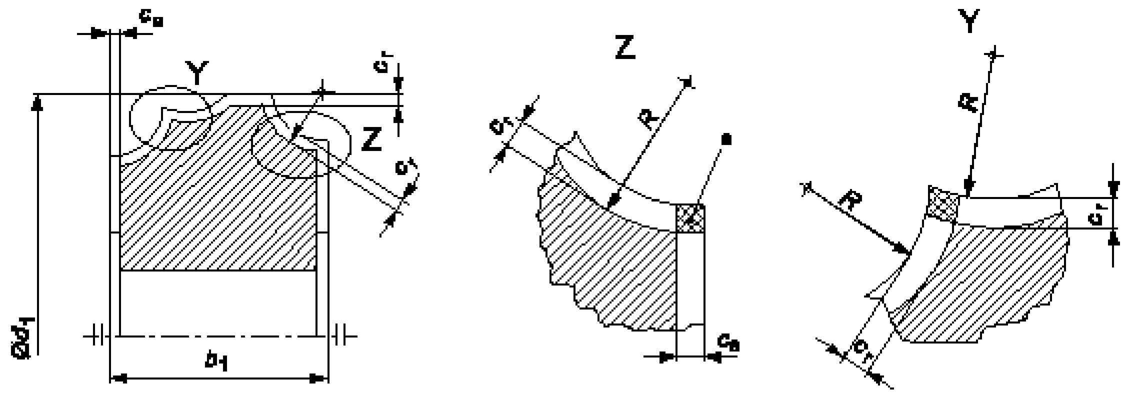
Key

1 screw at the choice of the manufacturer

Figure 1 — Milling tool with a spur

3.1.12
cutting diameter
d_1 (cutting radius r_1)
for tools where various blades can be mounted, the cutting diameter d_1 (cutting radius r_1) is the maximum possible value

Note 1 to entry: See Figure 2.



a Shaded area (see 5.2.1.2)

Figure 2 — Cutting diameter and cutting width

3.1.13
cutting width
b_1
for tools where various blades can be mounted, the cutting width b_1 is the maximum possible value

Note 1 to entry: See Figure 2.

3.1.14
deflector
projecting part exchangeably mounted or firmly connected by bonding to the body or part of the body which performs chip thickness limitation

Note 1 to entry: The deflector can also be called a "counter-knife".

Note 2 to entry: See Figures 3 b), c), d), e) and g).

3.1.15
cutting blade projection
t
difference between the radius r_1 of the cutting circle and the radius r_5 of the back supporting circle where $t = r_1 - r_5$

Note 1 to entry: See Figure 3.

3.1.16
radial cutting edge projection
c_r
difference between the deflector (not round form tools) or the body (round form tools) and the cutting edge measured in the direction of the normal to the profile

Note 1 to entry: See Figures 2 and 3.

3.1.17
axial cutting edge projection
c_a
distance measured axially between the axial cutting edge and the body or the deflector

Note 1 to entry: See Figure 3 a) and Figure 3 d).

3.1.18
round form tool
tool where the body has a circular shape in any cross section perpendicular to the rotational axis of the tool and which performs chip thickness limitation

Note 1 to entry: Auxiliary cutting parts with a deflector or spurs (see 3.1.10 and 3.1.11) are not considered.

Note 2 to entry: See Figures 3 a) and 5.

3.1.19
not round form tool
tool where chip thickness limitation is performed by a deflector (see Figures 3 b), c), d), e) and g)) or where a cross section of the body is not circular

Note 1 to entry: See Figure 3 f).

3.1.20
round form tool set
functional unit consisting of a number of individual not round form and/or round form tools clamped together and forming a round form tool shape with radial gaps of less than 5 mm and axial gaps less than 15 mm and the top and the bottom side is a full round

3.1.21
tool combination
unit consisting of a number of loose tools connectable in a variable sequence or extendable in a variable position

3.1.22
non-separable fixing
bonding of the tool components to the body which prevents their change of position relative to each other

3.1.23
separable fixing
fixing of the tool components to the body which allows their change of position relative to each other

3.1.23.1
friction lock fixing
fixing where the relative change of position in a radial direction during rotation is prevented only by the friction forces

Note 1 to entry: See Figure 4.

3.1.23.2
form lock fixing
fixing where the relative change of position in the radial direction during rotation is prevented by the form and arrangement of the components

Note 1 to entry: See Figure 5.

3.1.24
radial and axial approach flats
flat on the radial and/or axial surface of the deflector or of the body, in front of the deflector edge

Note 1 to entry: See Figure 6.

3.1.25
radial approach angle
τ_r
angle between the approach flat and the tangent to the deflector circle at the deflector edge or to the body circle at the point where the radial approach flat begins

Note 1 to entry: See Figure 6.

3.1.26
axial approach angle
τ_a
angle between a plane perpendicular to the axis of the tool and the axial approach flat

Note 1 to entry: See Figure 6.

3.1.27
basic number of teeth
number of teeth cutting in each part of the profile

3.1.28
woodworking machine
machine or a combination of machines intended for machining of wood and similar materials (see 3.1.29) by chip removal, or chipless cutting, sanding and forming, laminating (including gluing and edging) or joining

3.1.29
similar materials
materials with physical and technological characteristics similar to those of wood, such as cork, bone, plastics, light alloys, wood based materials as chipboard, fibreboard, plywood, etc. and for which the process for machining and chip or particle removal is similar

3.1.30
tools
all individual tools and tool sets for the mechanical removal of chips e.g. circular saw blades, bandsaw blades, milling cutters, chain cutters. Tools also include devices for forming and shaping or chipless cutting

3.1.31
hand feed
manual holding and/or guiding of the workpiece or of a machine element incorporating a tool

Note 1 to entry: Hand feed includes the use of hand-operated carriage on which the workpiece is placed manually or clamped and the use of demountable power feed unit (see 3.1.36).

3.1.32
integrated feed
feed mechanism for the workpiece or tool which is integrated with the machine and where the workpiece or machine element with incorporated tool is held and controlled mechanically during the machining operation

3.1.33
maximum rotational speed
maximum rotational speed for the operation for which the tool is designed

3.1.34
speed range
minimum and maximum rotational speeds within which the tool spindle or tool is designed to operate

3.1.35
loading the machine
manual or automatic placing of the workpiece onto a carriage, magazine, lift, hopper, movable bed, conveyor or the presentation of the workpiece to an integrated feed device

3.1.36
demountable power feed unit
feed mechanism which is mounted on the machine so that it can be moved from the working position without the use of a spanner or similar additional device

3.1.37
ejection
uncontrolled movement of the workpiece, parts of it, parts of machines or uncontrolled movement of hand-held machines during processing

3.1.38
kickback
particular form of ejection (see 3.1.37) describing the uncontrolled movement of the workpiece or parts of it opposite to the direction of feed during processing

3.1.39
chip breaking item
characteristic feature suitable to deflect the chip (e.g. to upset the chip) with the aim of reducing the presplitting of the workpiece material

Note 1 to entry: The chip breaking item may be a separate or an integral element of the cutting part.

3.1.40
gullet width
s
tangential distance from the cutting edge to the point at which the contour of the tool abandons the circle with radius r_2

Note 1 to entry: See Figure 3 a) and Figure 3 g).

3.2 Symbols and abbreviations

SP Alloyed tool steel (minimum 0,6 % C and no more than 5 % alloy constituents)

HL High alloyed tool steel (more than 5 % alloy units, e.g. 12 % Cr)

HS High speed steel (more than 12 % total of alloying components W, Mo, V, Co)

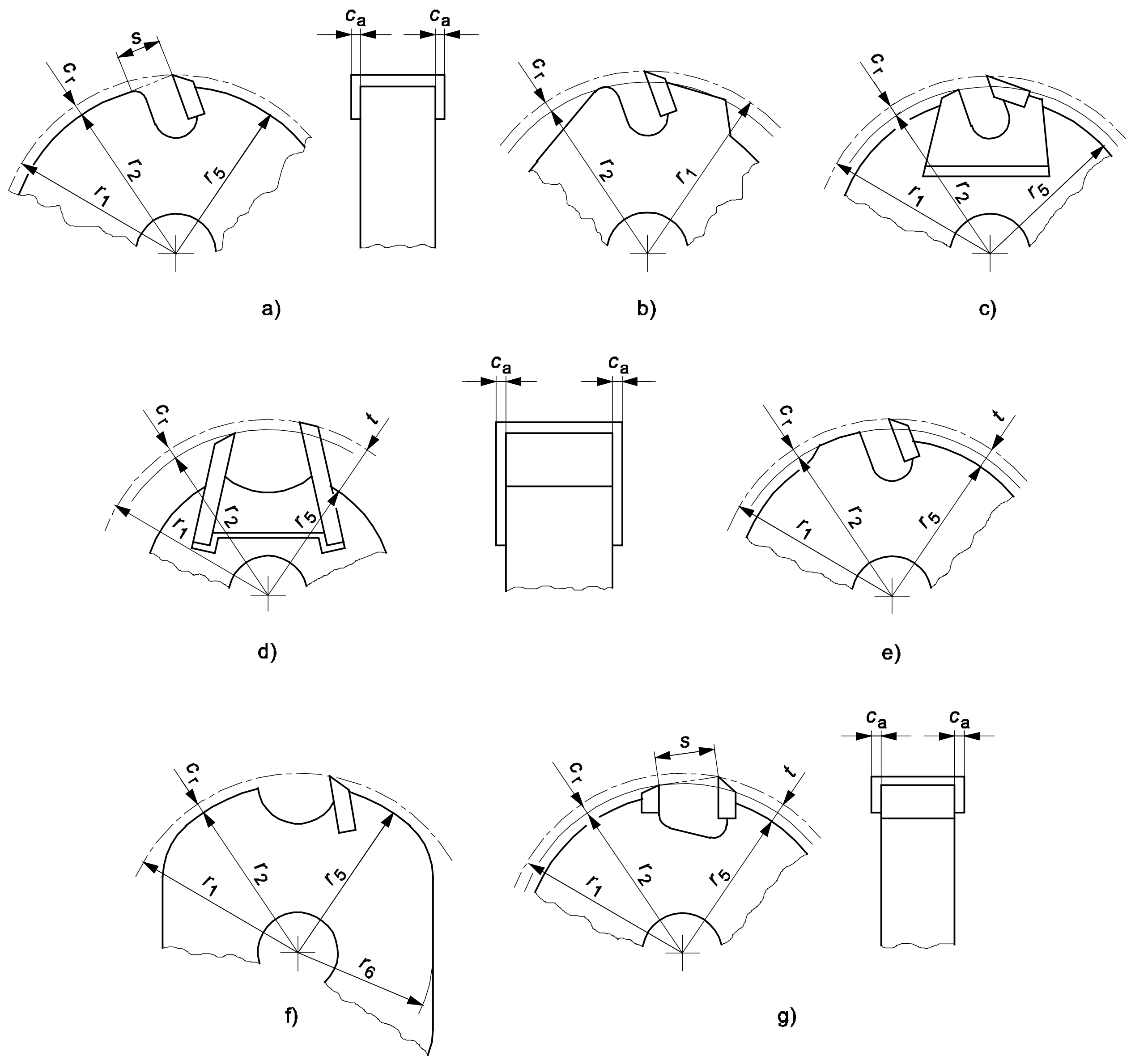
HW Uncoated hardmetal on tungsten carbide base [ISO 513:2012]

HC Coated hardmetal [ISO 513:2012]

ST Cast cobalt-based alloys, e.g. Stellites

DP Polycrystalline diamond [ISO 513:2012]

DM Monocrystalline diamond



In Figure 3 a) is $r_2 = r_5$.

Figure 3 — Deflector

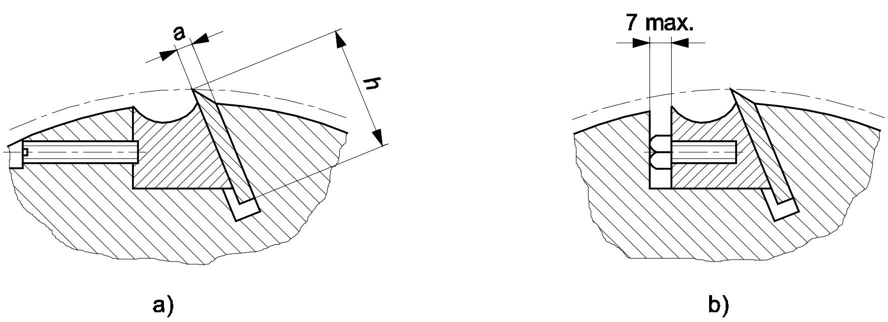


Figure 4 — Friction lock fixing

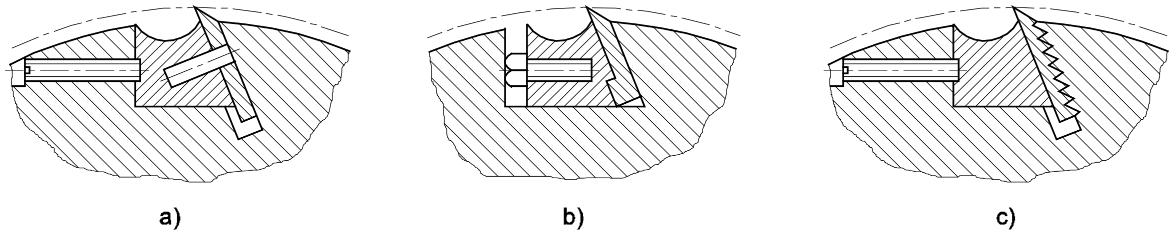
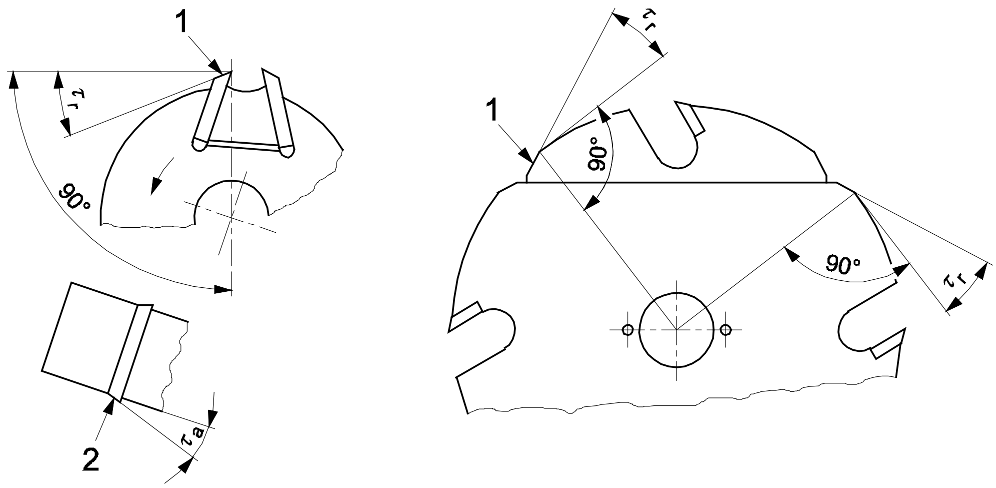


Figure 5 — Form lock fixing



Key

1 radial approach flat

2 axial approach flat

Figure 6 — Radial and axial approach flats

4 List of significant hazards

Table 1 shows the list of significant hazards.

Table 1 — Significant hazards

Hazard	Condition or causes of hazard related to the tool	Corresponding clause of EN 847-1
Cutting and severing	cutting hazard when mounting or dismounting the tool	5.1.7, Clause 7
	kickback or contact with the rotating tool	5.2
Ejection of parts	disintegration or partial break up to tool body	5.1.2, 5.1.4, 5.1.5.2, 5.1.5.3, 5.2.2, 6.1, 6.2, 6.3, 6.4, 6.5, 7.2.1, 7.2.2, 7.2.3, 7.2.4, 7.3
	incorrect assembly of tool components	5.1.3, 5.1.5, 7.2.4, 7.3.3
	movements of blades fixed by friction	5.1.3
	fly in/out of blades or separate components	5.1.3, 5.1.4, 5.1.5.2, 5.1.5.3
	unbalance of the tool while rotating	5.1.6.1, 5.2.3
	kickback when machining	5.1.4.2, 5.2, 5.2.1
	fixing of the tool on the machine spindle	5.1.6.2, 7.3
	modification of position of tool components	5.2.2, 7.3.5
Vibrations	unbalance of tool	5.1.6.1, 5.2.3

5 Design requirements

5.1 General requirements for milling tools and circular saw blades

5.1.1 General

Tools shall be designed and made of such materials in order that they will withstand the forces and loads expected when used and maintained in compliance with the manufacturer's instructions.

5.1.2 Safety requirements and/or measures

One piece (solid), composite and complex tools shall be designed with a safety factor as given in Table 2.

Table 2 — Safety factors

Type of tool	Method of procedure	Safety factor
One piece (solid) and composite tools	Calculation of stresses or centrifugal test against fracture	Safety factor of 4 means $n_p = 2 \times n_{\text{max}}$
Complex tools	Test procedure described under 5.1.4	Safety factor of 2,25 means $n_p = 1{,}5 \times n_{\text{max}}$

NOTE n_p is the test speed for overspeed test.

An overspeed type test is required for complex tools (see 5.1.4).

For tools with a cutting radius of $r_1 \leq 20$ mm a load of 50 N/mm shall be assumed. For tools with a cutting radius of $r_1 > 20$ mm the following formula applies for the calculation of the cutting force per millimetre:

$$F_m = \frac{30 \cdot P_{Mot}}{r_1 \cdot b_1 \cdot n_{max} \cdot \pi} \cdot 10^6 \quad (1)$$

where

F_m is the specific cutting force [N/mm];

P_{Mot} is the spindle motor power [kW];

r_1 is the cutting radius [mm];

b_1 is the cutting width [mm];

n_{max} is the maximum rotational speed [min^{-1}].

Verification: By checking calculations or using the test procedure described in 5.1.4.

5.1.3 Separable fixing

5.1.3.1 Form lock fixing and friction lock fixing

Form lock fixing shall be used for complex tools with the exception of the following cases where friction lock fixing may also be used:

- cutting blades used in milling tools for surface planing and thicknessing machines whose cutting width is at least 150 mm;
- cutting blades (except moulding and bevel blades) used in milling tools for machines with integrated feed;
- tools used in chipping and flaking machines with integrated feed.

Verification: By checking relevant drawings, measurement and visual inspection of the tool.

5.1.3.2 Clamping parts

The design of a complex tool, which includes a deflector, shall ensure that clamping of the knife can only be achieved with the deflector in position.

Form lock fixing shall ensure a positive mechanical fastening between the separable tool elements, and shall not rely on friction alone between the clamped parts. Examples of positive mechanical locks are: pin(s), screw(s), slots, notches.

Where a pin lock is used, at least 1 pin per blade (see Figure 7) shall be used for cutting blade widths up to 30 mm and at least 2 pins per blade for cutting blade width over 30 mm.

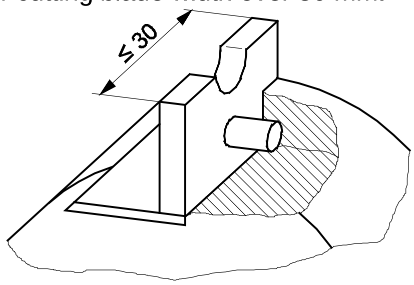


Figure 7 — Complex tool pin locking

For planing and combined planing and thicknessing machine milling tools, where fixing of the wedges is by means of screws (see Figures 4 b) and 5 b)), at least two screws are required for each wedge.

The distance between the back of the wedges and the body shall not exceed 7 mm when the cutting blade is in position (see Figure 4 b)).

Verification: By checking the relevant drawing, measurement and visual inspection of the tool and by checking that the knife cannot be clamped without the deflector in position.

5.1.3.3 Position of the chip breakers

When using a chip breaking item (see 3.1.39), c_c shall be minimum 1,0 mm (see Figure 8).

For round form tools with a cutting edge projection of c_r and $c_a \leq 1{,}1$ mm a c_c of minimum 0,6 mm is allowed (see Figure 8).

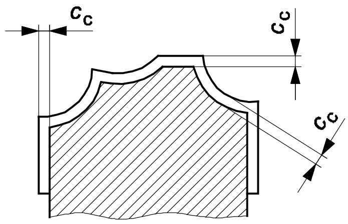


Figure 8 — Minimum distance of the chip breaking item (c_c) from the cutting edge

5.1.4 Overspeed type test for complex tools

5.1.4.1 Test conditions

The strength of complex tools to withstand the expected centrifugal forces to be seen in use is considered proven if, during an overspeed test of a sample tool at speeds

$$n_p = 1{,}5 \times n_{\text{max}} \quad n_p \text{ in min}^{-1} \qquad (2)$$

the relative displacements of detachable tool parts shall at no point be greater than indicated in the test procedure (see 5.1.4.2).

Tension elements shall be tightened to torque figures indicated by the manufacturer.

5.1.4.2 Test procedure

a) Measure the tool dimensions.

b) Bring the tool to its maximum rotational speed $n_{\text{max.}}$ for 1 min.

c) Stop and re-measure the tool; measured displacements shall not be greater than 0,15 mm.

d) Bring the tool to the test speed n_p for 1 min.

e) Stop and re-measure the tool and compare the results with those obtained from step 3. The compared displacements shall not exceed 0,15 mm.

The overspeed test shall be conducted with blanks for the largest cutting diameter and the largest cutting width.

In deviation from the specifications given above, for milling tools with centrifugal wedges, greater displacements of the centrifugal wedge are permissible in consideration of the following conditions:

- the tool is calculated for the most unfavourable tolerances and for test speed np with the stresses in the elastic range;
- the displacement of the centrifugal wedges shall not adversely influence the function and behaviour of the tool (kickback behaviour, chip removal, etc.);
- for the testing of the tool with centrifugal wedge it is required to apply the test as defined in 5.1.4.2, whereby the wedge shall be positioned correctly in accordance with the manufacturer's instructions before the first step (a)) of the test.

5.1.5 Cutting blade thickness and cutting blade projection

5.1.5.1 General

For cutting materials HS, HL, and SP as well as for one piece or composite cutting blades (see Terms and definitions in Clause 3) the relationship between cutting blade thickness *a* and cutting blade projection *t* is determined from the formulae shown in 5.1.5.2 and for one piece hardmetal (carbide) cutting blades (cutting material groups HW and HC), composite milling tools and circular saw blades from the formulae shown in 5.1.5.3.

The minimum cutting blade thickness a_{min} is shown in Figure 9.

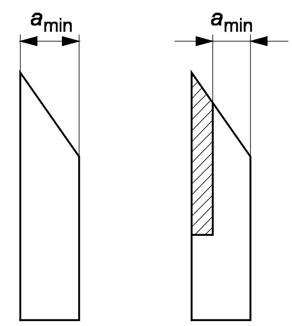


Figure 9 — Minimum cutting blade thickness

5.1.5.2 One piece or composite cutting blades (HS, HL and SP cutting materials)

One piece or composite cutting blades (HS, HL and SP cutting materials) shall be designed and manufactured in a way which ensures that the relation between cutting blade thickness and cutting blade projection is according to the below formulae.

Cutting blade thickness $= a$
Cutting blade projection $= t$

0,4 mm $\leq a \leq$ 1,0 mm $t_{max} = a$ $(a_{min} = t)$ (3)

1,0 mm $< a \leq$ 2,0 mm $t_{max} = 4 \times a - 3$ $(a_{min} = 0{,}25 \times t + 0{,}75)$ (4)

$a >$ 2,0 mm $t_{max} = 8 \times a - 11$ $(a_{min} = 0{,}125 \times t + 1{,}40)$ (5)

5.1.5.3 One piece hardmetal (HW, HC) cutting blades, composite milling tools and circular saw blades

One piece hardmetal (HW, HC) cutting blades, composite milling tools and circular saw blades shall be designed and manufactured in a way which ensures that the relation between cutting blade thickness and cutting blade projection is according to the below formulae.

Cutting blade thickness $= a$
Cutting blade projection $= t$

$tmax = (1{,}84 \times a) - 0{,}20$ $(amin = 0{,}54 \times t + 0{,}11)$ (6)

a_{min} = 0,4 mm for composite milling tools and composite circular saw blades

Hardmetal grades for one piece cutting blades for woodworking shall have the following minimal fracture toughness, measured by the Palmqvist Toughness Test (see Annex B), according to cutting blade thickness (see Table 3).

Table 3 — Fracture toughness

Fracture toughness K_{IC}	One piece cutting blade thickness a_{min}
Unknown value of K_{IC}	≥ 1,0 mm
$7 \leq K_{IC} < 8$	≥ 0,8 mm
$K_{IC} \geq 8$	≥ 0,6 mm

5.1.6 Dimensions and tolerances

5.1.6.1 Bore tolerances

Bore diameters shall be toleranced as follows:

— bores of milling tools ≥ 16 mm H7 in accordance with ISO 286-2;

— bores of milling tools > 10 mm < 16 mm H8 in accordance with ISO 286-2;

— bores of milling tools ≤ 10 mm H9 in accordance with ISO 286-2;

— bores of circular saw blades > 16 mm H8 in accordance with ISO 286-2;

— bores of circular saw blades ≤ 16 mm H9 in accordance with ISO 286-2.

Verification: By checking relevant drawings and measurement.

5.1.6.2 Hub diameter and tolerances

The minimum hub diameter $d_{4\,min}$ shall be:

$$d_{4\,min} = 1{,}4 \cdot d_3, \quad \text{for } d_3 \leq 50 \text{ mm}; \tag{7}$$

$$d_{4\,min} = d_3 + 20 \text{ mm}, \quad \text{for } d_3 > 50 \text{ mm}. \tag{8}$$

The run-out tolerance shall be measured at the outside diameter of the hub. The parallelism tolerance shall be measured at the hub flat surfaces.

The tolerances shall be in accordance with Figure 10.

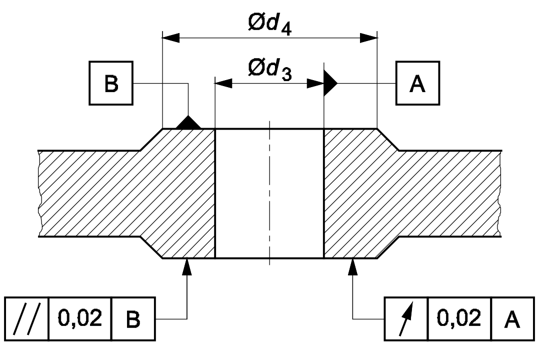


Figure 10 — Hub tolerances

Clamping surface. Tolerances of parallel sided tools should be the same as those for hubs.

Verification: By checking relevant drawings and measurement.

5.1.7 Handling of detachable tools with $m > 15$ kg

Detachable tools which weigh more than 15 kg shall be designed so that they can be fitted with attachments for handling (e.g. threaded holes) or be shaped in such a way that standard handling device can easily be attached.

NOTE See also 7.4.

Verification: By checking relevant drawings, measurement and visual inspection of the tool.

5.2 Specific requirements for milling tools

5.2.1 Tools for hand fed machines

To reduce the severity of the injury in contacting tools and the speed of kickback the following requirements apply.

5.2.1.1 Tool form

Milling tools for hand fed machines shall be either round form tools (see 3.1.18) or not round form tools (see 3.1.19).

Tools for planing and combined planing and thicknessing machines shall be round form tools only.

Verification: By checking relevant drawings, measurement and visual inspection of the tool.

5.2.1.2 Cutting edge projection and basic number of teeth

Tools with a cutting diameter less than 70 mm shall have a radial cutting edge projection ≤ 1,1 mm.

Tools for manufacturing finger joints (see Figure 11) shall fulfil the following requirements:

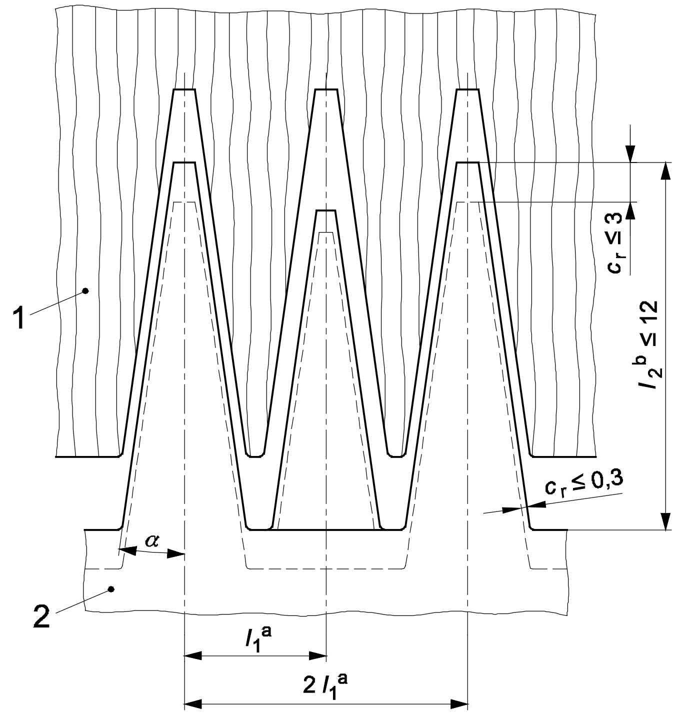
— radial cutting edge projection for the flanks $c_r \leq 0{,}3$ mm;

— radial cutting edge projection for the outer diameter $c_r \leq 3{,}0$ mm;

— flank angle (α) = 4° to 10°;

— finger length (l_2) ≤ 12 mm;

— pitch (l_1) ≥ 3,8 mm.



Key

1 work piece

2 tool for manufacturing finger joints

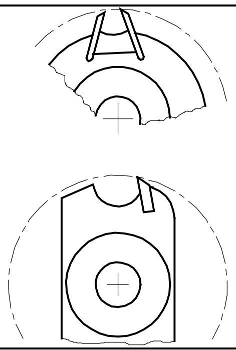
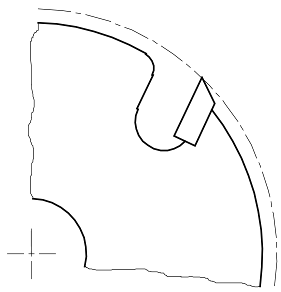
a (l1) pitch

b (l2) finger length

Figure 11 — Tool for manufacturing finger joints

Round form tools for machines other than planing or combined planing and thicknessing machines shall be so designed that the radial cutting edge projection (chip thickness limitation) *cr*, defined in 3.1.16, the axial cutting edge projection *ca*, defined in 3.1.17 and the maximum basic number of teeth fulfil the limitations indicated in Table 4.

Table 4 — Cutting edge projection and maximum basic number of teeth

		Maximum basic number of teeth Z_{max}	
		Not round form	Round form
			
c_r, c_a	1,1 mm	2 [a]	4 [b]
	2,0 mm	not allowed	4
	3,0 mm	not allowed	3

[a] Exceptions for groove and rebate cutters:

$b_1 \leq 20$ mm $Z_{max} = 8$.

[b] Exceptions for grooving and rebating tools:

$b_1 \leq 10$ mm $Z_{max} = 12$

10 mm $< b_1 \leq 50$ mm $Z_{max} = 8$.

For single tools and not adjustable tool sets each overlapping of cutting edges shall not exceed 6,0 mm. Otherwise both overlapping cutting edges are to be counted.

For adjustable tools the overlapping shall not exceed 50 % of the cutting width of each single cutting edge. Otherwise both overlapping cutting edges are to be counted.

Tools for planing or combined planing and thicknessing machines shall be round form tools and designed so that the radial cutting edge projection is $c_r \leq 1{,}1$ mm.

Not round form tools shall be designed so that the radial and axial cutting edge projections are $c_r \leq 1{,}1$ mm and $c_a \leq 1{,}1$ mm.

The requirements of this clause (5.2.1.2) do not apply to spurs. The maximum projection of the spur is equal to the radial cutting edge projection and/or axial cutting edge projection plus max. 0,5 mm.

The cutting edge projection c_r and c_a of auxiliary cutting parts with a deflector shall be ≤ 1,1 mm.

Form lock tools shall be designed so that the cutting edge projections c_r and c_a cannot be exceeded.

Whatever the shape of the profile, the radial cutting edge projection c_r described above shall be maintained along the whole length of the profile except the shaded area shown in Figure 2.

Verification: By checking relevant drawings and measurement.

5.2.1.3 Maximum gullet width s_{max}

Maximum gullet width s_{max} for cutting diameters d_1 from 16 mm to 400 mm shall be measured at the maximum cutting circle.

This shall include the regrinding range and shall be selected in accordance with the requirements of Figure 12.

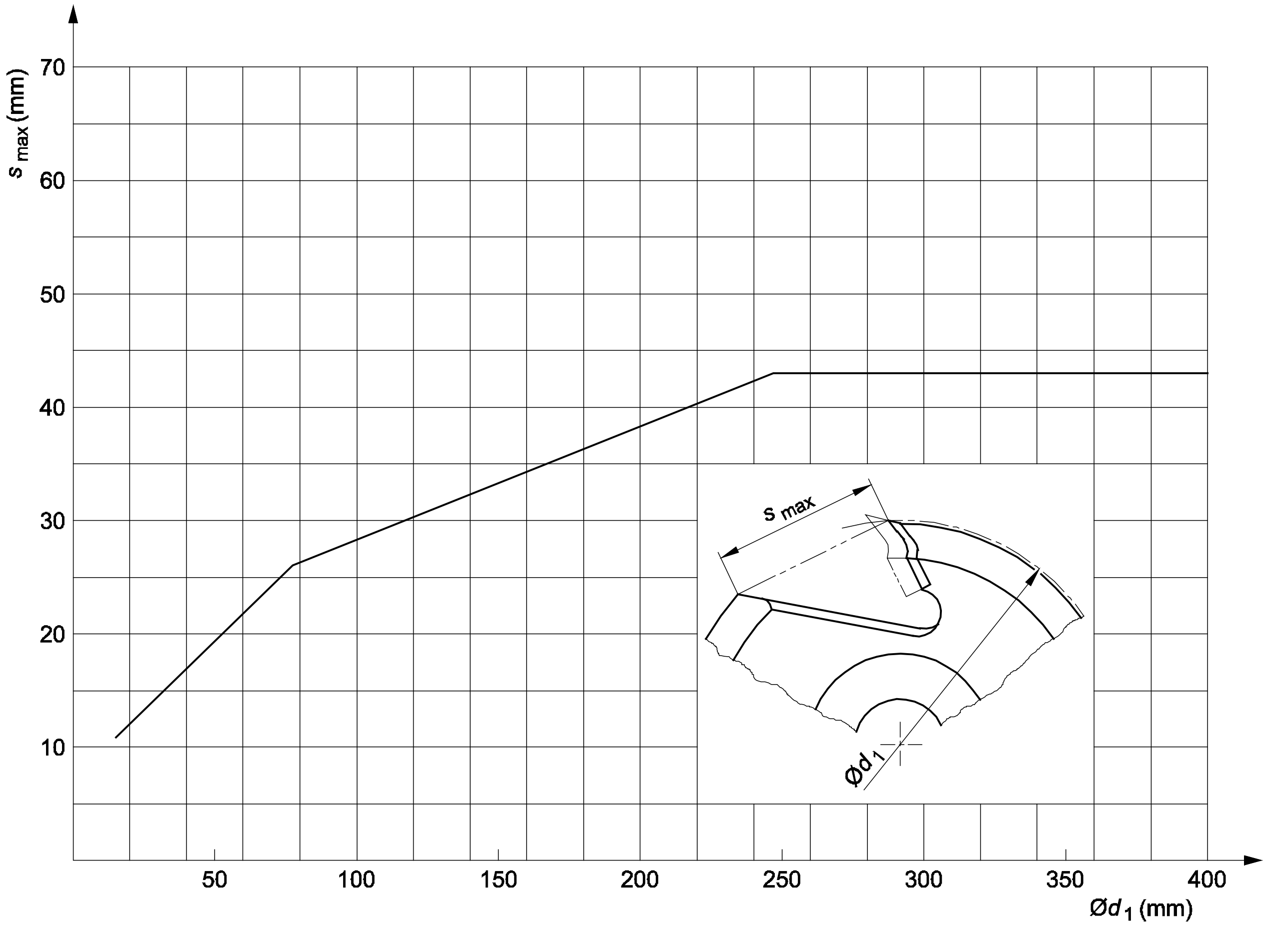


Figure 12 — Maximum gullet width with s_{max}

The graph shown in Figure 12 is based on the following formulae:

$s_{max} = 0{,}235 \times d_1 + 7{,}2$ for $16 \leq d_1 \leq 80$

$s_{max} = 0{,}1 \times d_1 + 18$ for $80 < d_1 \leq 250$ s_{max} in mm

$s_{max} = 43$ for $d_1 > 250$

(9)

Verification: By checking relevant drawings, measurement and visual inspection of the tool.

5.2.1.4 Minimum diameter of the body d_{min}

For not round form tools the minimum diameter d_{min} of the body (equal to $2 \times r_5$ in Figures 3 c), d), e) and g) and $2 \times r_6$ in Figure 3 f)) shall be selected in accordance with the requirements of Figure 13.

The diagram in Figure 13 is based on the following formulae:

$d_{min} = 0,6 \times d_1$ for $16 \leq d_1 \leq 80$

$d_{min} = 0,642 \times d_1 - 3,34$ for $80 < d_1 \leq 270$ d_{min} in mm

$d_{min} = d_1 - 100$ for $d_1 > 270$

(10)

Tools belonging to a tool set, or part of extendable tools may have gaps for the cutting parts of neighbouring tools, which differ from Figure 13.

Verification: By checking relevant drawings, measurement and visual inspection of the tool.

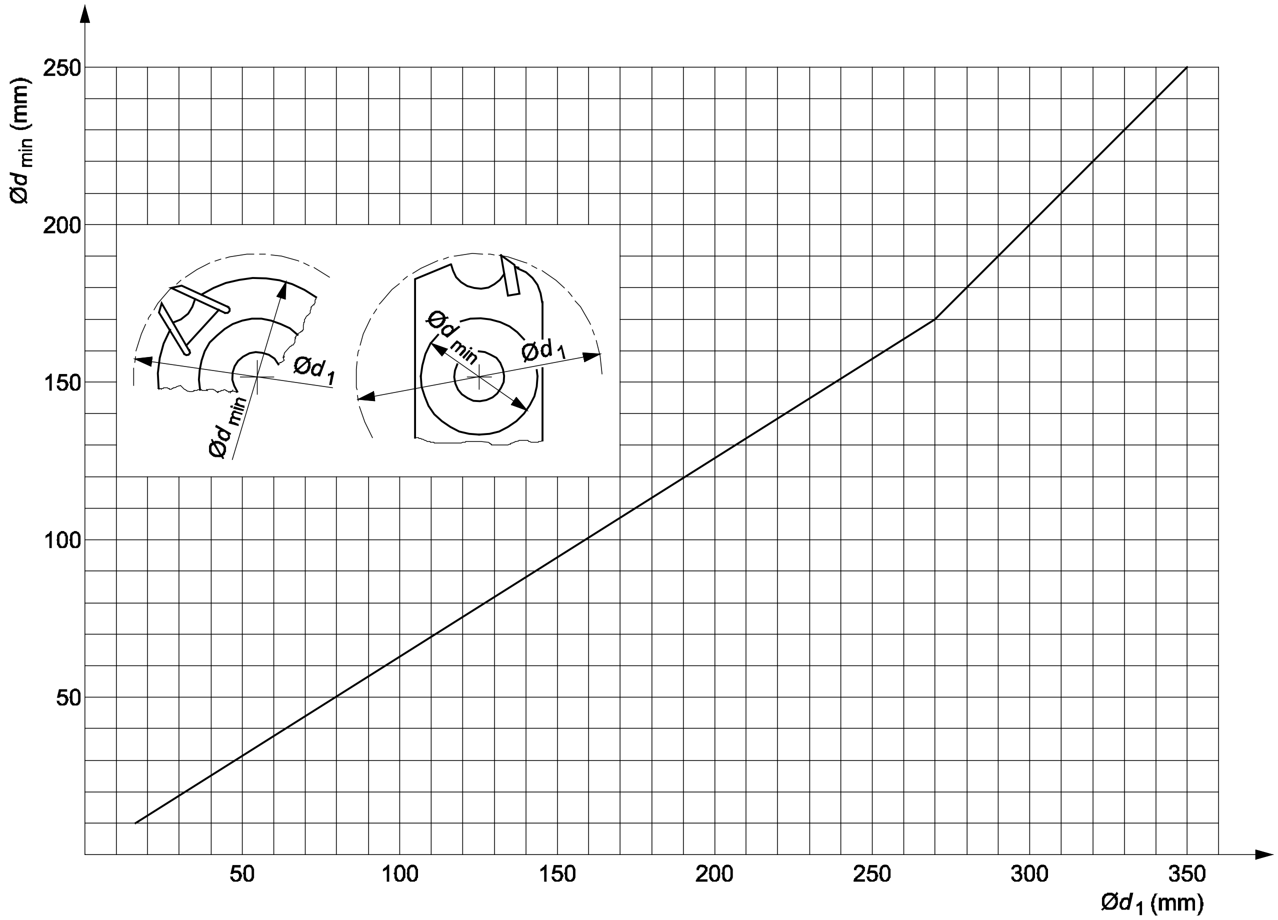


Figure 13 — Minimum diameter of the body d_{min} for not round form tools

5.2.1.5 Approach angles τ_r and τ_a

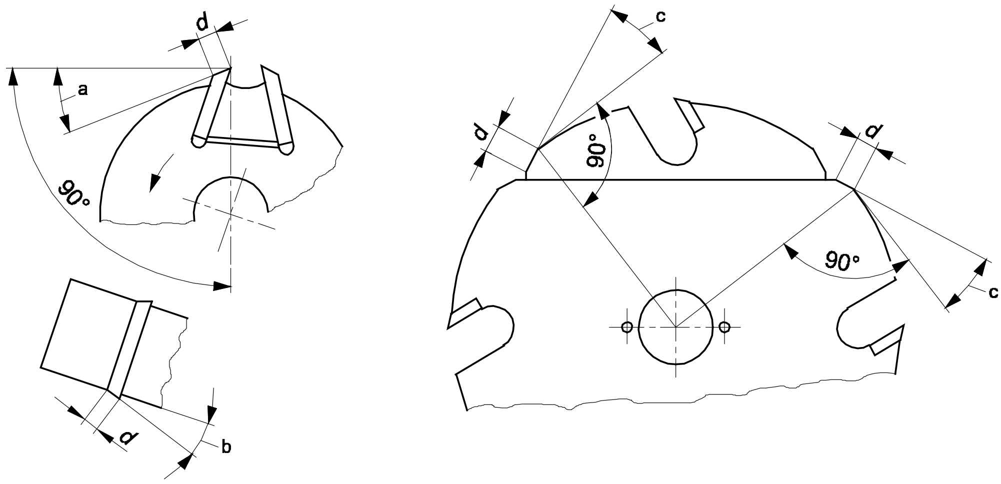
Not round form tools shall be provided with radial (τ_r) and axial (τ_a) approach angles in accordance with the requirements of Figure 14.

The requirements for axial approach angles do not apply to auxiliary cutting parts.

For deflectors the radial approach angle τ_r and the axial approach angle τ_a shall be 5° to 30°. For all other cases the radial and axial approach angle shall be 18° to 25°.

The radial and axial approach angles are measured at the maximum value of the deflector circle diameter or the body circle diameter (see Figure 3).

The deflecting width shall be at least 2 mm (see Figure 14).



Key

a τ_r = 5° – 30°
b τ_a = 5° – 30°
c τ_r = 18° – 25°
d Deflecting width ≥ 2 mm

Figure 14 — Not round form tool approach angles

Verification: By checking relevant drawings, measurement and visual inspection of the tool.

5.2.1.6 Tool combinations for hand fed machines

Tools belonging to a tool combination for hand fed machines, which do not in themselves meet the requirements for hand feed, shall be prevented from being used individually by means of design, e.g. by pins (see e.g. Figure 15). For using the single tools individually open gaps in the tool body shall be covered by additional parts to get a round form tool.

Verification: By checking relevant drawings and visual inspection of the tool.

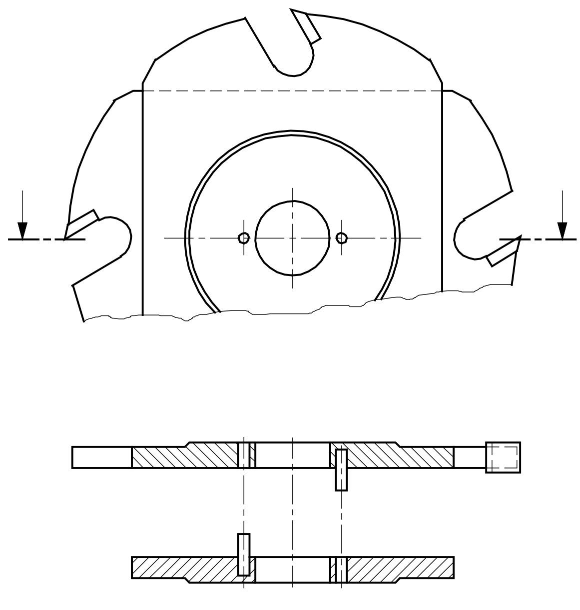


Figure 15 — Design of tools for hand fed machines to prevent individual use

5.2.2 Prevention of relative rotation within a tool combination

Individual tools in tool combinations, whose cutting edges can be damaged if, by relative rotation, they come into contact with each other, shall be provided with a means of preventing this from occurring (see e.g. Figure 16).

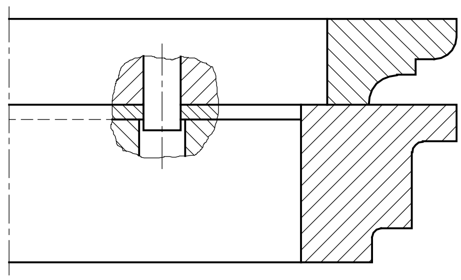


Figure 16 — Prevention of relative rotation between tool elements

Verification: By checking relevant drawings and visual inspection of the tool.

5.2.3 Balance of milling tools

5.2.3.1 General requirements

Tool sets shall be balanced as a complete assembly. Each tool of a tool set or a tool combination shall be balanced separately.

Tools with keyways shall be balanced without keys.

5.2.3.2 Balance quality requirements

The balance quality requirements shown in Table 5 shall be applied.

Table 5 — Balance quality requirements

Number	Type of tool	G-value = e_{per} according to ISO 1940-1	Formula (expands ISO 1940-1)	Explanation to the formula
1	One piece tools, composite tools and bodies for complex tools other than integrated tools, all with mass $m \geq$ 250 g	16	$U_T^* = 1{,}527\,9 \times 10^5 \times \frac{1}{n_{max}}$	The value of 1,527 9 is the product of: $e_{per} \times \omega \times 10^3 \times \frac{60}{2 \times \pi}$
2	Integrated tool bodies for planing and combined planing and thicknessing machines, all with mass $m \geq$ 250 g	6,3	$U_T^* = 0{,}601\,6 \times 10^5 \times \frac{1}{n_{max}}$	The value of 0,601 6 is the product of: $e_{per} \times \omega \times 10^3 \times \frac{60}{2 \times \pi}$
3	Complex tools and tool sets with mass $m \geq$ 250 g, and all other tools with mass 250 g $\leq m <$ 1 000 g	40	$U_G^* = 3{,}819\,7 \times 10^5 \times \frac{1}{n_{max}}$	The value of 3,819 7 is the product of: $e_{per} \times \omega \times 10^3 \times \frac{60}{2 \times \pi}$
4	All tools with mass $m <$ 250 g	100	$U_G^* = 9{,}5493 \times 10^5 \times \frac{1}{n_{max}}$	The value of 9,549 3 is the product of: $e_{per} \times \omega \times 10^3 \times \frac{60}{2 \times \pi}$

Table 6 — Quantities and units

Quantity	Symbol	Unit
Maximum permissible speed	n_{max}	in min^{-1}
Permissible specific residual imbalance for one piece and composite tools and for bodies	U_T^*	in $\frac{g \cdot mm}{kg}$
Permissible specific residual imbalance for complex tools	U_G^*	in $\frac{g \cdot mm}{kg}$

Verification: By measurement of the tool.

6 Tool identification

6.1 Marking of milling tools for integrated feed other than shank mounted tools or integrated tools

Milling tools with radial adjustable cutting parts shall be marked with the limit of the clamping position, e.g. with a dash.

Milling tools to be used on machines only with integrated feed shall be clearly and permanently marked at least with:

- the name or trademark of the manufacturer or supplier;
- the maximum rotational speed e.g. n max. 6 000;
- the tool dimensions ((cutting diameter) (see 3.1.12)) × ((cutting width) (see 3.1.13)) × (bore diameter);
- for one piece and composite tools, the tool cutting material group symbol (see 3.2);
- MEC (for integrated feed).

NOTE Permanently marked means, e.g. engraving, etching or embossing stamping. A character height of 3 mm, where possible, is considered acceptable.

Verification: By checking relevant drawings and visual inspection.

6.2 Marking of milling tools for machines with hand feed other than shank mounted tools or integrated tools

Milling tools with radial adjustable cutting parts shall be marked with the limit of the clamping position, e.g. with a dash.

Tools for use on hand fed machines shall be clearly and permanently marked at least with:

- the name or trademark of the manufacturer or supplier;
- the maximum rotational speed (e. g. n 3 000) or the speed range (n 4 500 to 9 000).

Where achievable a minimum cutting speed of 40 m/s is recommended.

- the tool dimensions of ((cutting diameter) (see 3.1.12)) × ((cutting width) (see 3.1.13)) × (bore diameter);
- MAN (for hand feed);
- for one piece and composite tools, the tool cutting material group symbol (see 3.2).

NOTE Permanently marked means, e.g. engraving, etching or embossing stamping. A character height of 3 mm, where possible, is considered acceptable.

Verification: By checking relevant drawings and visual inspection.

6.3 Marking of integrated tools

Integrated tools with radial adjustable cutting parts shall be marked with the limit of the clamping position, e.g. with a dash.

Integrated tools shall be clearly and permanently marked at least with:

— the name or trademark of the manufacturer or supplier;

— MEC (for integrated feed) or MAN (for hand feed).

NOTE Permanently marked means, e.g. engraving, etching or embossing stamping. A character height of 3 mm, where possible, is considered acceptable.

Verification: By checking relevant drawings and visual inspection.

6.4 Marking of shank mounted tools

Shank mounted tools with radial adjustable cutting parts shall be marked with the limit of the clamping position, e.g. with a dash.

Shank mounted tools shall be marked with:

— the name or trademark of the manufacturer or supplier;

— the maximum rotational speed e.g. n max. 12 000 or the value of nshank according to EN 847-2 for milling tools with cylindrical shank whichever is the lower;

— MEC (for integrated feed) or MAN (for hand feed);

— the cutting material group symbol (see 3.2) for shank diameter ≥ 14 mm;

— the maximum free shank length according to EN 847-2 for milling tools with cylindrical shank;

— the permissible eccentricity (e.g. nmax 12 000 e 0,06) according to EN 847-2 for milling tools with cylindrical shank;

— the tool dimensions ((cutting diameter) (see 3.1.12)) × ((cutting width) (see 3.1.13)) × (shank diameter) for shank diameter ≥ 14 mm.

NOTE Permanently marked means, e.g. engraving, etching or embossing stamping. A character height of 3 mm, where possible, is considered acceptable.

Verification: By checking relevant drawings, measurement and visual inspection.

6.5 Marking of circular saw blades

Circular saw blades shall be marked clearly and permanently at least with:

— the name or trademark of the manufacturer or supplier;

— the maximum rotational speed e.g. *n* max. 4 500;

— the tool dimensions of (cutting diameter) × (kerf) × (bore diameter);

— for one piece and composite circular saw blades the tool cutting material group (see 3.2).

NOTE Permanently marked means, e.g. engraving, etching or embossing stamping. A character height of 3 mm, where possible, is considered acceptable.

Verification: By checking relevant drawings and visual inspection.

6.6 Marking of cutting parts and deflectors

Cutting parts and deflectors for complex tools, except auxiliary cutting parts, and cutting parts with one dimension of a width or a height of ≤ 20 mm as well as spurs, shall be clearly and permanently marked at least with the name or trademark of the manufacturer or supplier.

Cutting parts and deflectors intended for use on hand feed machines, and not profiled by the manufacturer or user, shall be clearly and permanently marked with the name or trademark of the profile manufacturer.

Cutting parts and loose deflectors shall be clearly and permanently identified in sets.

Marking shall be provided where possible on the reverse (back) of the cutting blades and deflectors.

For HW cutting blades with a thickness less than 1,0 mm or capable to be ground down to less than 1,0 mm the tool cutting material group symbol (see 3.2, symbol 4) shall be followed by the fracture toughness according to Table 3 and Annex C in a two digit form, i.e. HW 08.

NOTE Permanently marked means, e.g. engraving, etching or embossing stamping. A character height of 3 mm, where possible, is considered acceptable.

Verification: By checking relevant drawings and visual inspection.

7 Information for use

7.1 General

The manufacturer shall provide all relevant safety information with the tool, according to this clause. The manufacturer shall declare in the information for use and sales literature that the tools have been manufactured in accordance with this document.

Tools shall be used only by persons of training and experience who have knowledge of how to use and handle tools.

7.2 Safe working practice

The following information of the safe working practice shall be given, if applicable.

7.2.1 Maximum speed

The maximum rotational speed marked on the tool shall not be exceeded. Where stated, the speed range shall be adhered to.

7.2.2 Circular saw blades

Circular saw blades, the bodies of which are cracked, shall be scrapped (repairing is not permitted).

7.2.3 One piece tools

Tools with visible cracks shall not be used.

7.2.4 Cleaning

Tools shall be cleaned regularly.

Light alloy tool parts shall only be cleaned, e.g. from resin, with solvents that do not affect the mechanical characteristics of these materials.

7.2.5 Mounting and fastening of tools and tool parts

For fastening of the tools and their tool parts the following instructions shall be given:

a) Tools and tool bodies shall be clamped in such a way that they shall not loosen during operation.

b) Shank mounted tools shall be clamped in such a way that the mark for the free shank length, l_0 or the minimum clamping length $l_{\mathrm{e\ min}}$ is at least covered partially or fully by the chuck.

c) For tools with friction lock a setting gauge shall be used to maintain radial and axial cutter projections c_{r} and c_a.

d) Care shall be taken of mounting tools to ensure that the clamping is by the hub respectively by the clamping surface of the tool and that the cutting edges are not in contact with each other or with the clamping elements.

e) Fastening screws and nuts shall be tightened using the appropriate spanners, etc. and to the torque value provided by the manufacturer.

f) Extension of the spanner or tightening using hammer blows is not permitted.

g) Clamping surfaces shall be cleaned to remove dirt, grease, oil and water.

h) Clamping screws shall be tightened according to instructions.

i) To adjust the bore diameter of circular saw blades to the spindle diameter of the machine only fixed rings, e.g. pressed or held by adhesive fixing, shall be used. The use of loose rings is not permitted.

j) When mounting radial adjustable cutting parts the limit of the clamping position given as a mark on the tool body, e.g. as a dash, shall be respected.

7.3 Maintenance of tools

Maintenance of tools, e.g. repair or regrinding, shall only be allowed according to the tool manufacturer's instructions which may additionally include the content of Annex A.

If maintenance of tools is allowed by the manufacturer, the information for use shall cover the following aspects, if applicable:

a) After maintenance of tools it shall be ensured that the tools observe balancing requirements as mentioned in 5.2.3.2.

b) The design of composite (tipped) tools shall not be changed in the process of repair.

c) Composite tools shall be repaired by a competent person, i.e. a person of training and experience, who has knowledge of the design requirements and understands the level of safety to be achieved.

d) Spare parts shall be in accordance with the specification of the original parts provided by the manufacturer.

e) Tolerances which ensure correct clamping shall be maintained.

f) For one piece tools care shall be taken that regrinding of the cutting edge will not cause weakening of the hub and the connection of the cutting edge to the hub.

7.4 Handling

To avoid injuries, tools shall be handled in accordance with the guidance provided by the manufacturer. Typically, safe handling involves the use of devices such as carrying hooks, proprietary handles, frames (e.g. for circular saw blades), boxes, trolleys etc. The wearing of protective gloves improves the grip on the tool and further reduces the risk of injury.

Tools which weigh more than 15 kg may require the use of special handling devices or attachments, these will depend on the features that the manufacturer has designed into the tool to allow easy handling (see 5.1.7). The manufacturer can advise on the availability of necessary devices.

Examples of special handling devices are shown in Figure 17 to Figure 20.

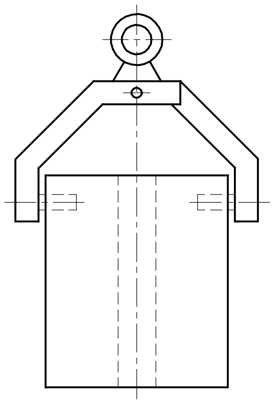


Figure 17 — Example of handling device

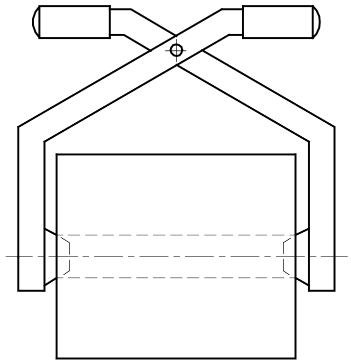


Figure 18 — Example of handling device

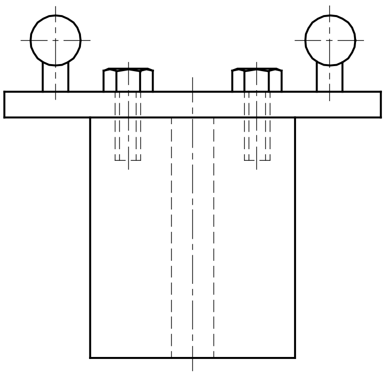


Figure 19 — Example of handling device

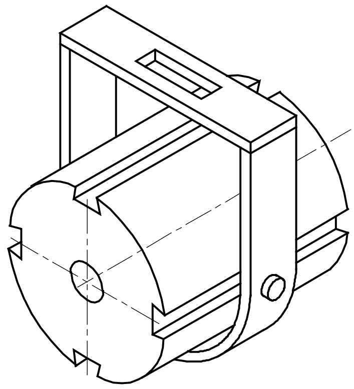


Figure 20 — Example of handling device

Verification: By inspection of the sales literature, instruction handbook or information for use.

Annex A
(informative)

Maintenance and modification of milling tools and related components

A.1 General

Maintenance and modification of milling tools and related components and circular saw blades should always be in accordance with the design requirements/the manufacturer's instructions. Maintenance and modification of milling tools and circular saw blades should only be carried out by a competent person, i.e. a person of training and experience, who has knowledge of the design requirements and understand levels of safety to be achieved.

A.2 Minimum dimensions

When regrinding milling tools and circular saw blades, the minimum requirements of cutting blade thickness and cutting blade projection shown in 5.1.5 should be observed.

A.3 Retipping, exchange of tips on composite tools and circular saw blades

Composite tools should be repaired by persons experienced in and with understanding of design and use of milling tools for processing wood and similar materials, e.g. an expert with a relevant education and knowledge of the brazing process, including in particular the influence of the brazing process on tension in tool body and cutting material. When brazing off worn tips and subsequently brazing on new tips it should be made sure that the tip is correctly mounted in the tool body and that the process does not result in critical tension in the tool body.

A.4 Milling tools marked with MAN

After any type of maintenance, milling tools marked with MAN should continue to observe the requirements of the standards related to tools for hand feed (see 5.2.1).

A.5 Balance of milling tools

When modifying milling tools, e.g. modification of bore diameter, modification of shank, retipping of composite tools and similar, it should be ensured that the requirements of the standard relating to balancing (5.2.3) are still observed.

A.6 Marking

After being modified and/or retipped, milling tools and circular saw blades should be marked according to the rules applying to new tools. However, the name/logo of the company making the modification/retipping should be added.

A.7 Information

When relevant, user instructions should be enclosed with reground or retipped tools.

Annex B
(normative)

Palmqvist Toughness Test

a) Prepare a test piece with a plane, polished surface free of scratches, internal stresses and deformations.

b) Determinate the Vickers hardness HV30 in accordance with EN 23878.

c) Measure the length of the four cracks (see Figure B.1) which are caused by the Vickers hardness test.

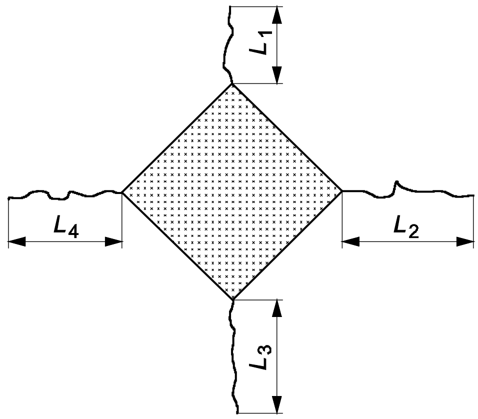


Figure B.1 — Cracks caused by the Vickers hardness test

d) Determinate the fracture toughness test (Palmqvist - No.) with the following formula:

$$K_{IC} = A \times \frac{\mathrm{HV} \times P}{\sum L} \quad \text{(B.1)}$$

where

K_{IC}	=	Palmqvist -Number	$\left[\mathrm{MPa\,m}^{-\frac{1}{2}}\right]$
A	=	0,027 5 (Shetty constant)	[—]
HV	=	Vickers hardness	[kg/mm^2]
P	=	Test force	[N]
ΣL	=	$L_1 + L_2 + L_3 + L_4$	[mm]

Bibliography

[1] ISO 513:2012, *Classification and application of hard cutting materials for metal removal with defined cutting edges — Designation of the main groups and groups of application*

[2] ISO 3002-1:1982, *Basic quantities in cutting and grinding — Part 1: Geometry of the active part of cutting tools — General terms, reference systems, tool and working angles, chip breakers*

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