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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

Définitions de base pour la coupe et la rectification — Partie 1 : Géométrie de la partie active des outils coupants — Notions générales, système de référence, angles de l'outil et angles en travail, brise-copeaux

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3002/1 was developed by Technical Committee ISO/TC 29, *Small tools*.

The first edition (ISO 3002/1-1977) had been approved by the member bodies of the following countries :

Australia	India	South Africa, Rep. of
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No member body had expressed disapproval of the document.

Moreover, the above member bodies (with the exception of Bulgaria, Egypt, Arab Rep. of, India, New Zealand, Sweden and Thailand), as well as Mexico and Spain, had approved draft Addendum 1 to ISO/DIS 3002, which was incorporated into ISO 3002/1-1977.

This second edition, which cancels and replaces ISO 3002/1-1977, incorporates draft Addendum 1, which was circulated to the member bodies in October 1978 and has been approved by the member bodies of the following countries :

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It also incorporates draft Amendment 1, which was circulated to the member bodies in August 1979 and has been approved by the member bodies of the following countries:

Australia	Germany, F.R.	Poland
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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

1 Scope and field of application

This Part of ISO 3002 defines a nomenclature for certain basic concepts concerning cutting tools; it is applicable to the geometry of every kind of cutting tool and emphasizes a known terminology for them which is intended to provide a framework on which the nomenclature and appropriate standards for individual types of cutting tool, such as single-points tools, twist drills, milling cutters and hand tools, can be established. However, the standards for individual types of cutting tool will not each require or use the full range of terms and definitions set out in the basic nomenclature established in this Part of ISO 3002.

The definitions are grouped into four clauses. After defining the general terms for surfaces on the workpiece, certain elements of the tool, surfaces on the tool, the cutting edges and the tool and workpiece motions in clause 3, this Part of ISO 3002 defines, in clause 4, reference systems of planes which are subsequently used to define the various angles which are included in clause 5. Two reference systems of planes are necessary : one, the tool-in-hand system, is used to define the geometry of the tool so that it can be manufactured and measured; the other, the tool-in-use system, is required to define the effective geometry of the tool when it is actually performing the cutting operation. Clause 7 gives definitions relating to chip breakers.

ISO 3002/2 gives general conversion formulae to relate tool and working angles.

NOTE — In addition to terms used in the three official ISO languages (English, French and Russian), this Part of ISO 3002 gives the equivalent terms in German, Italian and Dutch; these have been included at the request of ISO Technical Committee 29 and are published under the responsibility of the member bodies for Germany, F.R. (DIN), Italy (UNI) and the Netherlands (NNI). However, only the terms and definitions given in the official languages can be considered as ISO terms and definitions.

2 Reference

ISO 3002/2, *Basic quantities in cutting and grinding — Part 2 : Geometry of the active part of cutting tools — General conversion formulae to relate tool and working angles.*

3 General terms

3.1 Surfaces on the workpiece

3.1.1 work surface (figure 1) : The surface on the workpiece to be removed by machining.

3.1.2 machined surface (figure 1) : The desired surface produced by the action of the cutting tool.

3.1.3 transient surface (figure 1) : The part of the surface which is formed on the workpiece by the cutting edge (3.4.1) and removed during the following cutting stroke, during the following revolution of the tool or workpiece, or by the following cutting edge.

3.2 Tool elements

3.2.1 body (figures 3 to 5) : The part of the tool which holds the cutting blades or inserts, or on which are formed the cutting edges (3.4.1).

3.2.2 shank (figures 2a, 4 and 5) : The part of the tool by which it is held.

3.2.3 tool bore (figure 3) : That bore in a tool by which it can be located and fixed by a spindle, arbor or mandrel.

3.2.4 tool axis (figures 3, 4 and 5) : An imaginary straight line with defined geometrical relationships to the locating surfaces used for the manufacture and sharpening of the tool and for holding the tool in use. Generally, the tool axis is the centreline of the tool shank or bore; it is usually parallel or perpendicular to the locating surfaces, although it could be the centreline of a conical surface as in the case of a taper shank. When not obvious, the tool axis must be defined by the designer.

3.2.5 cutting part (figure 2a) : The functional part of parts of the tool each comprised of chip producing elements; the cutting edges (3.4.1), face (3.3.1) and flank (3.3.2) are therefore elements of the cutting part.

In the case of a multi-toothed cutter, each tooth has a cutting part.

3.2.6 base (figures 2a, 12 and 18) : A flat surface on the tool shank, parallel or perpendicular to the tool reference plane (4.1.1), useful for locating or orienting the tool in its manufacture, sharpening and measurement.

Not all tools have a clearly defined base.

3.2.7 wedge (figures 3 and 7) : The portion of the cutting part enclosed between the face (3.3.1) and the flank (3.3.2). It can be associated with either the major or minor cutting edge (3.4.1).

3.3 Tool surfaces

Each tool surface is provided with a symbol consisting of the letter A with a suffix indicating the identity of the surface (for example A_f , the face). When it is necessary to distinguish clearly a surface associated with the minor cutting edge (3.4.1.2) the appropriate symbol bears a prime (for example $A_{f'}$, the minor flank).

3.3.1 face A_f (figures 2a, 3, 4, 5 and 7) : The surface or surfaces over which the chip flows. When the face is composed of a number of surfaces inclined to one another, these are designated first face, second face, etc, starting from the cutting edge. These surfaces may be called lands and unless otherwise specified it is assumed that these are associated with the major cutting edge (3.4.1.1).

Where it is necessary to distinguish the faces associated with the major and minor cutting edges (3.4.1.1 and 3.4.1.2), that part of the face which intersects the flank (3.3.2) to form the major cutting edge is called the major face and that part of the face which intersects the flank to form the minor cutting edge is called the minor face, for example major first face, minor first face, etc.

3.3.1.1 reduced face $\bar{A}_f$ (figure 2c) : A specially prepared surface or surfaces separated from the rest of the face by a step and designed in such a way that the chip contacts only the reduced face.

NOTE — A reduced face should not be confused with the land associated with a groove or step intended to induce chip breaking nor with multiple faces of the tool. The symbol $\bar{A}_f$ has been adopted to designate the reduced face and to distinguish it from lands on the tool face which are designated by A_{f1} , A_{f2} , etc.

3.3.1.2 chip breaker (see clause 7) : A modification of the face A_f , to control or break the chip, consisting of either an integral groove or an integral or attached obstruction.

3.3.2 flank A_α (figures 2a, 3, 4, 5 and 7) : The tool surface or surfaces over which the surface produced on the workpiece passes. When a flank is composed of a number of surfaces inclined to one another, these are designated first flank, second flank, etc., starting from the cutting edge. These surfaces may be called lands and unless otherwise specified it is assumed that these are associated with the major cutting edge (3.4.1.1).

Where it is necessary to distinguish the flanks associated with the major and minor cutting edges (3.4.1.1 and 3.4.1.2), that part of the flank which intersects the face to form the major cutting edge is called the major flank and that part of the flank which intersects the face to form the minor cutting edge is called the minor flank, for example major first flank, minor first flank, etc.

3.3.3 Profiles of the face and flank

3.3.3.1 face profile (figure 2d) : The curve formed by the intersection of the face A_f with any desired plane. Normally this profile is defined and measured in the cutting edge normal plane P_n (4.1.5). If it is to be defined in any other plane this must be clearly specified.

3.3.3.2 flank profile (figure 2d) : The curve formed by the intersection of flank A_α with any desired plane. Normally this profile is defined and measured in the cutting edge normal plane P_n (4.1.5). If it is to be defined in any other plane this must be clearly specified.

3.4 Cutting edges

3.4.1 cutting edge : That edge of the face which is intended to perform cutting.

3.4.1.1 tool major cutting edge S (figures 2a, 3, 4, 5 and 7) : That entire part of the cutting edge which commences at the point where the tool cutting edge angle κ_r is zero (5.1.1.1) and of which at least a portion is intended to produce the transient surface on the workpiece. In the case of tools having a sharp corner (3.4.2) at which the value of κ_r may be considered to pass through zero, the major cutting edge commences at that corner. In the case of tools for which the value of κ_r does not decrease to zero at any point on the cutting edge, the entire cutting edge is the tool major cutting edge as, for example, in the case of a slab milling cutter.

3.4.1.2 tool minor cutting edge S' (figures 2a, 3, 4 and 5) : The remainder of the cutting edge, if any, and where present commences at the point on the cutting edge where κ_r is zero (5.1.1.1) but extends from this point in a direction away from the tool major cutting edge. It is not intended to produce any of the transient surface on the workpiece. Some tools may have more than one tool minor cutting edge as, for example, in the case of a cutting-off tool.

3.4.1.3 working major cutting edge S_e (figure 2b) : That entire part of the cutting edge which commences at the point where the working cutting edge angle κ_{re} is zero (5.2.1.1) and of which at least a portion produces the transient surface on the workpiece. In the case of tools having a sharp corner (3.4.2) at which the value of κ_{re} may be considered to pass through zero, the working major cutting edge commences at that corner. In the case of tools for which the value of κ_{re} does not decrease to zero at any point on the cutting edge, the entire cutting edge is the working major cutting edge as, for example, in the case of a slab milling cutter.

3.4.1.4 working minor cutting edge S_e' (figure 2b) : The remainder of the cutting edge, if any, and where present commences at the point on the cutting edge where κ_{re} is zero (5.2.1.1) but extends from this point in a direction away from the working major cutting edge. It does not produce any of the transient surface on the workpiece. Some tools may have more than one working minor cutting edge, as for example, in the case of a cutting-off tool.

NOTE — A distinction must be made between the tool major cutting edge and the working major cutting edge because the points at which κ_r and κ_{re} can be considered to be zero are not, in general, coincident.

3.4.1.5 active cutting edge (figure 2b) : That portion of the working cutting edge which is actually engaged in cutting at a particular instant generating both the transient and machined surfaces on the workpiece.

3.4.1.5.1 active major cutting edge S_a : The portion of the active cutting edge measured along the cutting edge from the point of intersection of the cutting edge and work surface to the point on the working cutting edge at which the working cutting edge angle κ_{re} (5.2.1.1) may be considered to be zero.

3.4.1.5.2 active minor cutting edge S_a' : The portion of the active cutting edge measured along the cutting edge from the point at which the working cutting edge κ_{re} (5.2.1.1) may be considered to be zero to the point of intersection of the working minor cutting edge and the machined surface.

3.4.2 corner (figures 2 to 6a) : The relatively small portion of the cutting edge at the junction of the major and minor cutting edges; it may be curved, straight or the actual intersection of these cutting edges.

3.4.2.1 rounded corner (figure 6a) : A corner having a curved cutting edge.

3.4.2.2 chamfered corner (figure 6a) : A corner having a straight cutting edge.

3.4.3 selected point on the cutting edge : A point selected on any part of the cutting edge in order to define, for example, the tool or working angles at that point (5). The selected point may be on the major cutting edge or on the minor cutting edge. When the selected point is so chosen as to be located on the minor cutting edge, the planes and angles associated with this point are so designated (4 and 5).

3.4.4 rounded cutting edge : A cutting edge which is formed by a rounded transition between the face, A_y , and the flank, A_α .

3.4.5 interrupted cutting edge (figure 6b) : A cutting edge having discontinuities of sufficient magnitude as to prevent chip formation from taking place at the locations where they occur. (Such discontinuities are often used to reduce the size of the individual chips produced by a tool such as a slab milling cutter.)

3.4.6 tool profile : The curve formed by the orthogonal projection of the tool cutting edge, S , on any desired plane. Normally this profile is defined and measured in the tool reference

plane P_r (4.1.1). If it is to be defined in another plane, this shall be clearly specified.

3.5 Dimensions

The dimensions of the cutting edges are measured in the conventional manner but additional definitions are required and are given below.

3.5.1 corner radius r_c (figure 6a) : The nominal radius of a rounded corner measured in the tool reference plane, P_r (4.1.1).

3.5.2 chamfered corner length b_c (figure 6a) : The nominal length of a chamfered corner measured in the tool reference plane P_r (4.1.1).

3.5.3 land width b_y and b_α (figure 7) : The width of a land on the major face is designated by b_y and the width of a land on the minor face is designated by b_α .

The width of a land on the major flank is designated by b_α and the width of a land on the minor flank is designated by b_α' .

The identification number of the land together with the suffix used to identify the plane of measurement may be added if necessary, for example, b_{yn2} , b_{an1} , b_{an2}' .

3.5.4 rounded cutting edge radius r_n : The nominal radius of a rounded cutting edge measured in the cutting edge normal plane, P_n (4.1.5).

3.5.5 width of reduced face $\bar{b}_y$ (figure 2c) : The width of a reduced face is designated by $\bar{b}_y$ and is measured in the cutting edge normal plane P_n (4.1.5). If it is to be defined in any other plane this must be specified clearly : the suffix indicating the plane of measurement should be added to the basic symbol, i.e. $\bar{b}_{y0}$.

NOTE — The width of a reduced face should not be confused with the width of a land on the face. The symbol $\bar{b}_y$ has been adopted to designate the width of a reduced face to distinguish it from the width of a land on the face which is designated by b_y .

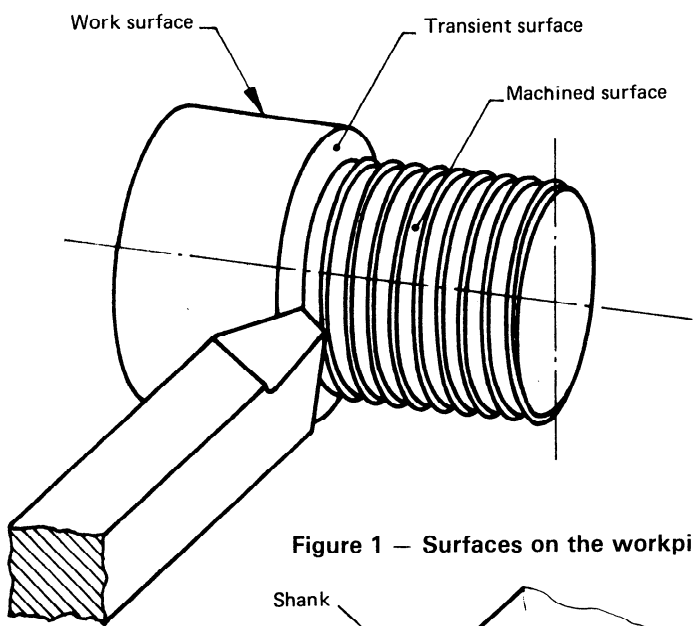


Figure 1 — Surfaces on the workpiece

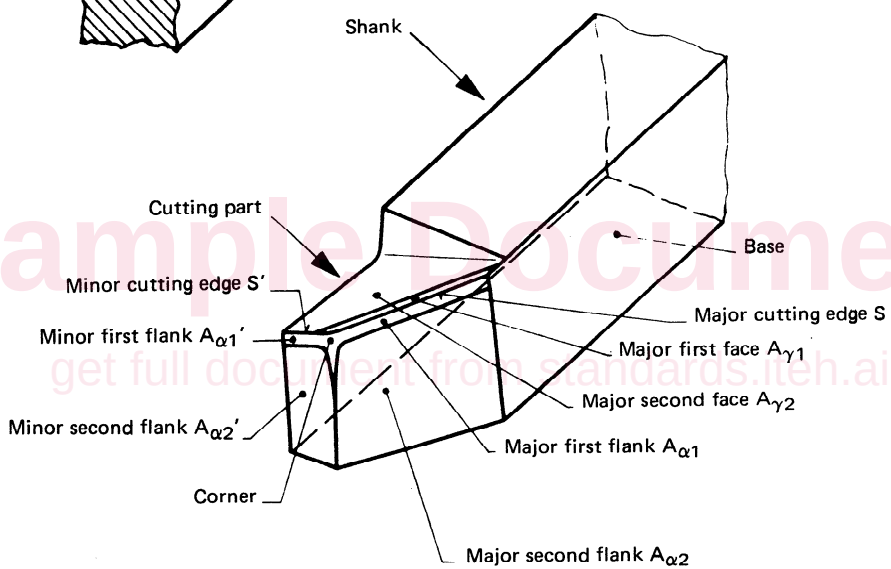


Figure 2a — Cutting edges and surfaces on the cutting part of a turning tool

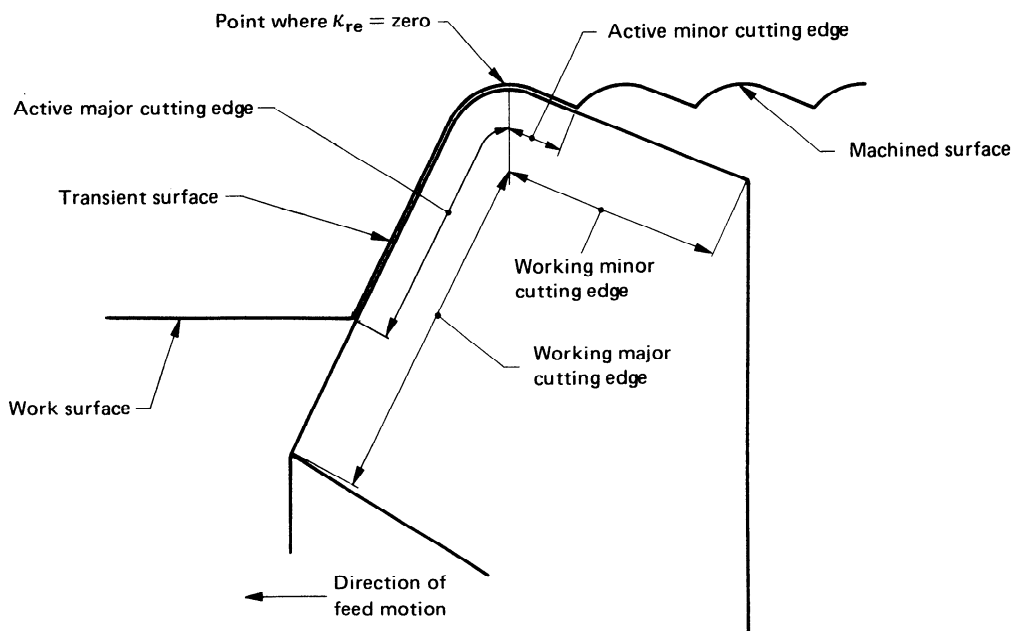


Figure 2b — Illustration of various terms relating to the tool and work piece

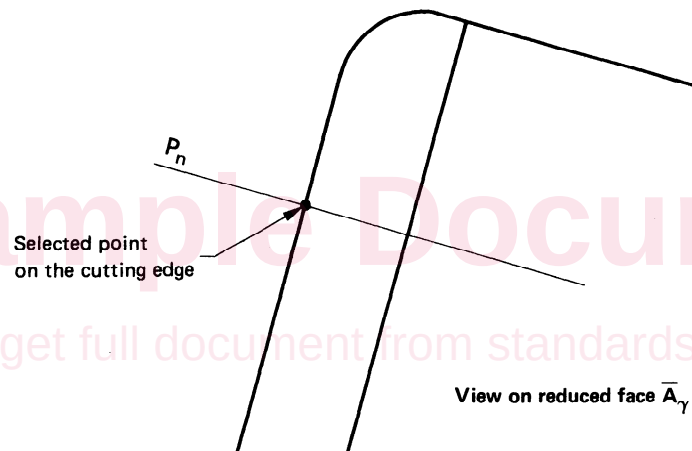
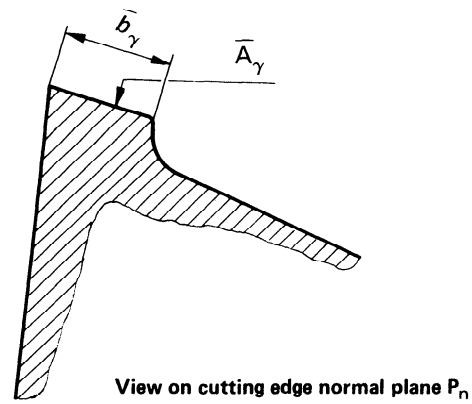


Figure 2c — Reduced face

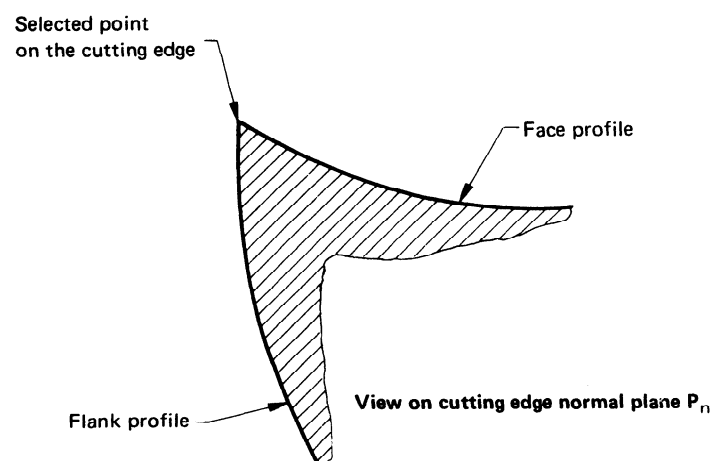


Figure 2d — Profiles of the face and flank

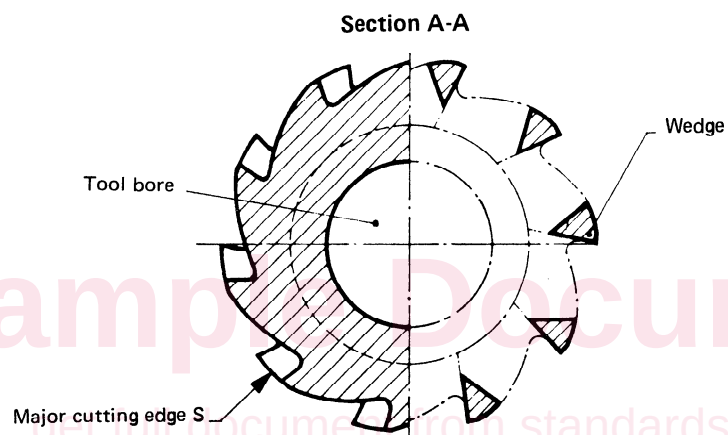
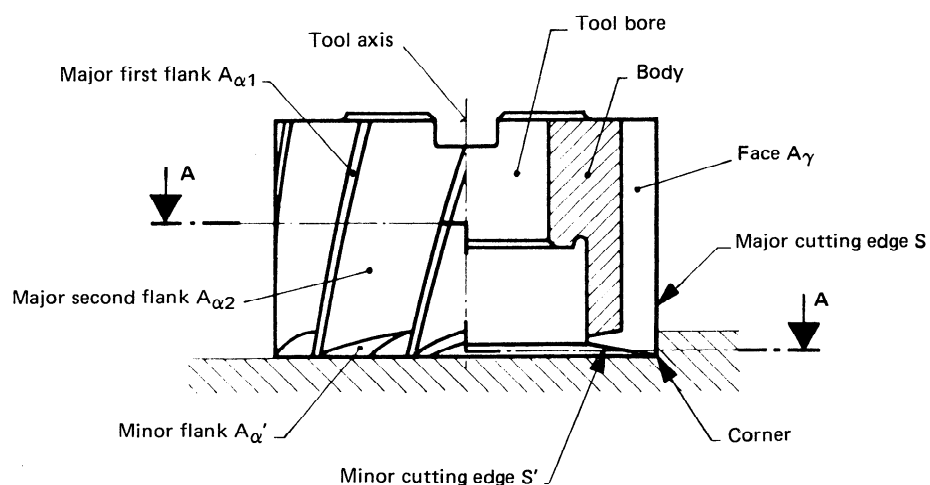


Figure 3 — Cutting edges and surfaces on the cutting part of a shell end mill

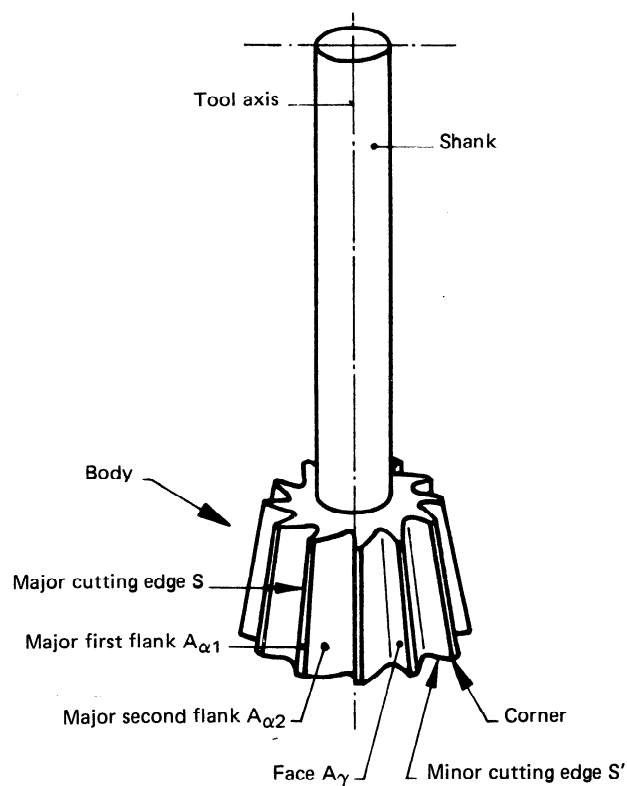


Figure 4 — Cutting edges and surfaces on the cutting part of a single cutter with parallel shank

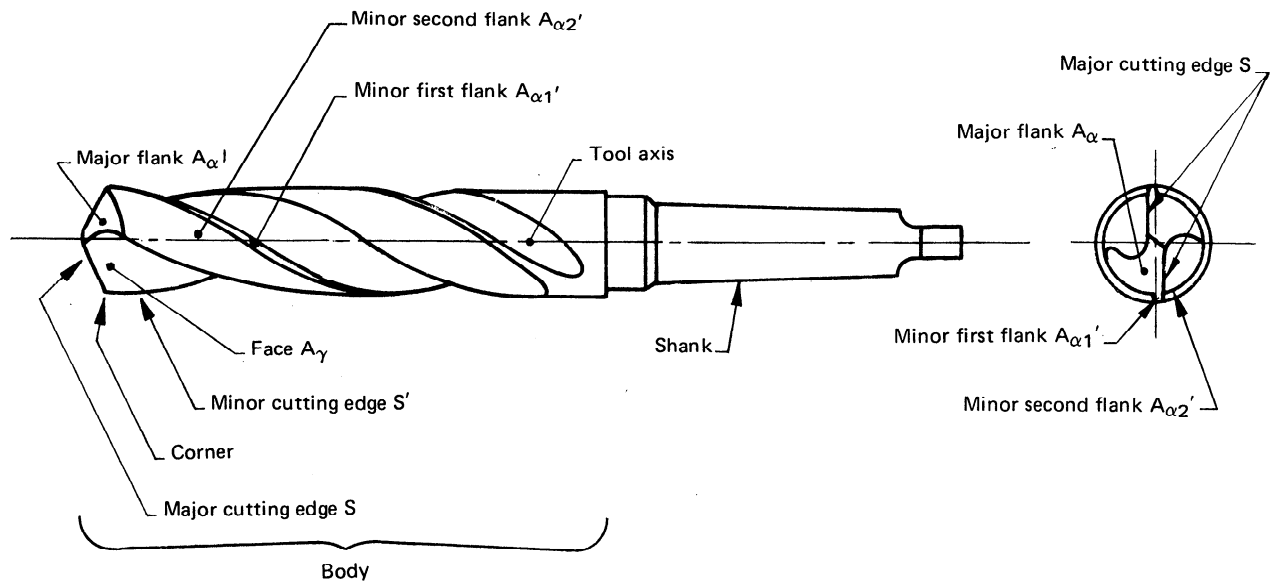


Figure 5 — Cutting edges and surfaces on the cutting part of a twist drill

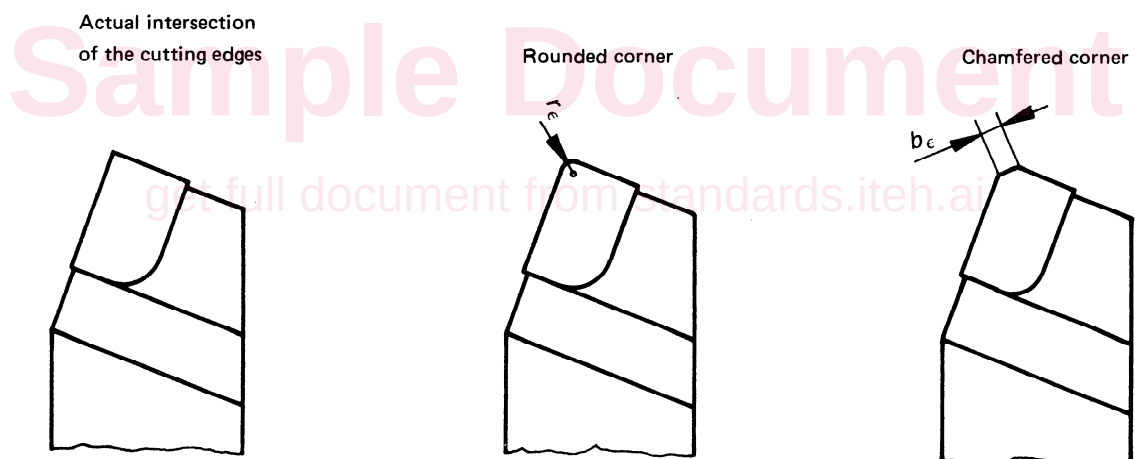


Figure 6a — Corners viewed in the tool reference plane P_r (4.2.1)

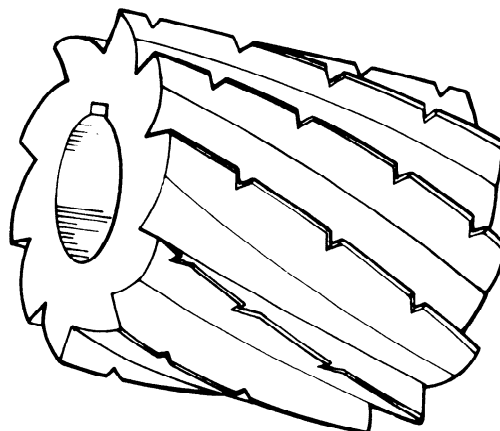


Figure 6b — Interrupted cutting edge

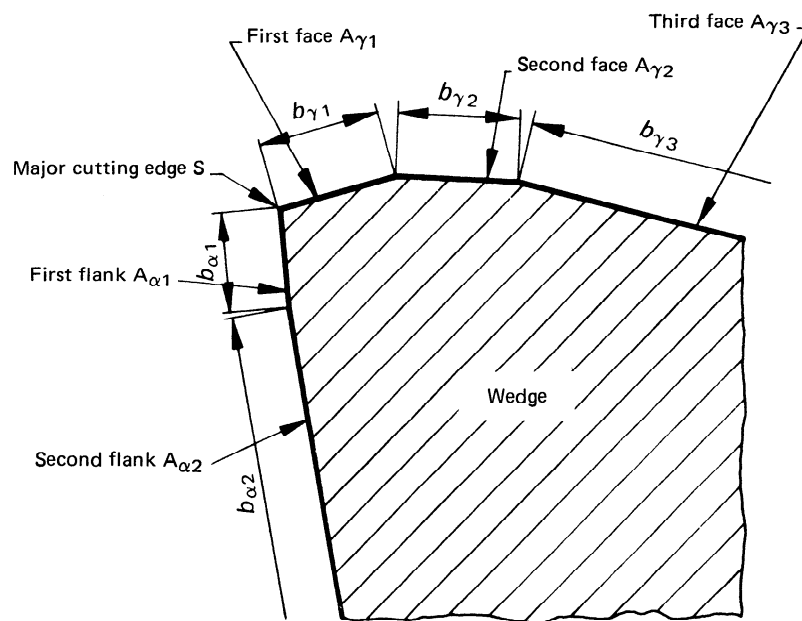


Figure 7 — Wedge with lands

3.6 Tool and workpiece motions

All motions, directions of motions and speeds are defined relative to the workpiece.

3.6.1 primary motion : The main motion provided by a machine tool or manually, to cause relative motion between the tool and workpiece so that the face of the tool approaches the workpiece material. In a lathe, this motion is provided by the rotary motion of the workpiece; in drilling and milling machines, it is provided by the rotary motion of the tool; in a planing machine it is provided by the longitudinal motion of the table. The primary motion is only able to cause chip removal for more than one revolution or stroke if there is a feed motion as defined in 3.6.2.

Usually, the primary motion absorbs most of the total power required to perform a machining operation.

3.6.1.1 direction of primary motion (figures 8 to 11) : The direction of instantaneous primary motion of the selected point on the cutting edge relative to the workpiece.

3.6.1.2 cutting speed v_c (figures 8 to 11) : The instantaneous velocity of the primary motion of the selected point on the cutting edge relative to the workpiece.

3.6.2 feed motion : A motion provided by a machine tool or manually, to cause an additional relative motion between the tool and workpiece, which, when added to the primary motion, leads to repeated or continuous chip removal and the creation of a machined surface with the desired geometric characteristics. This motion may proceed by steps or continuously; in either case it usually absorbs a small proportion of the total power required to perform a machining operation.

In certain machining operations, for example screw tapping and broaching, a feed motion as defined above is not required, the creation of the desired machined surface being achieved by the provision of an array of cutting edges which are arranged to

approach the workpiece in an ordered manner. In such cases, the feed motion is defined as the motion which an imaginary single cutting edge would have to be given by the machine tool to produce the same result as the array of cutting edges with which the tool is actually provided.

3.6.2.1 direction of feed motion (figures 8 to 11) : The direction of instantaneous feed motion of the selected point on the cutting edge relative to the workpiece.

3.6.2.2 feed speed v_f (figures 8 to 11) : The instantaneous velocity of the feed motion of the selected point on the cutting edge relative to the workpiece.

When the feed is intermittent, for example in the case of a planing operation, the feed speed is not defined.

3.6.3 resultant cutting motion : The motion resulting from simultaneous primary motion and feed motion.

3.6.3.1 resultant cutting direction (figures 8, 9 and 11) : The direction of instantaneous resultant cutting motion of the selected point on the cutting edge relative to the workpiece.

3.6.3.2 resultant cutting speed v_e (figures 8, 9 and 11) : The instantaneous velocity of the resultant cutting motion of the selected point on the cutting edge relative to the workpiece.

3.6.4 feed motion angle φ (figures 8 to 11) : The angle between the directions of simultaneous feed motion and primary motion. It is therefore measured in the working plane P_{fe} (4.2.2).

In certain machining operations such as in planing, shaping and broaching this angle cannot be defined.

3.6.5 resultant cutting speed angle η (figures 8, 9 and 11) : The angle between the direction of primary motion and the resultant cutting direction. It is therefore measured in the working plane P_{fe} (4.2.2).

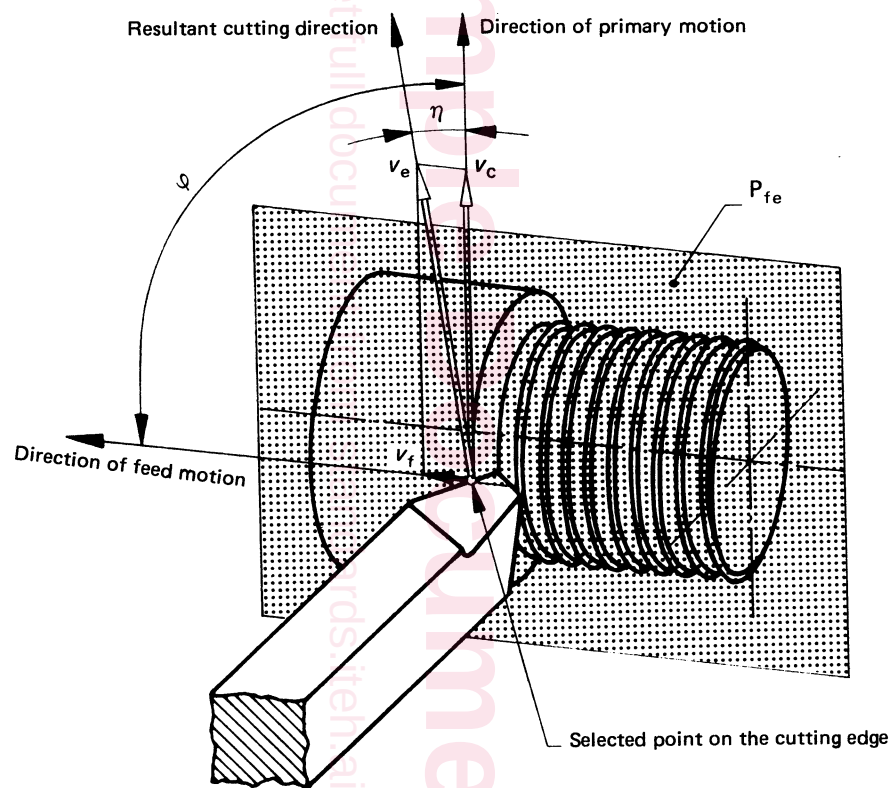
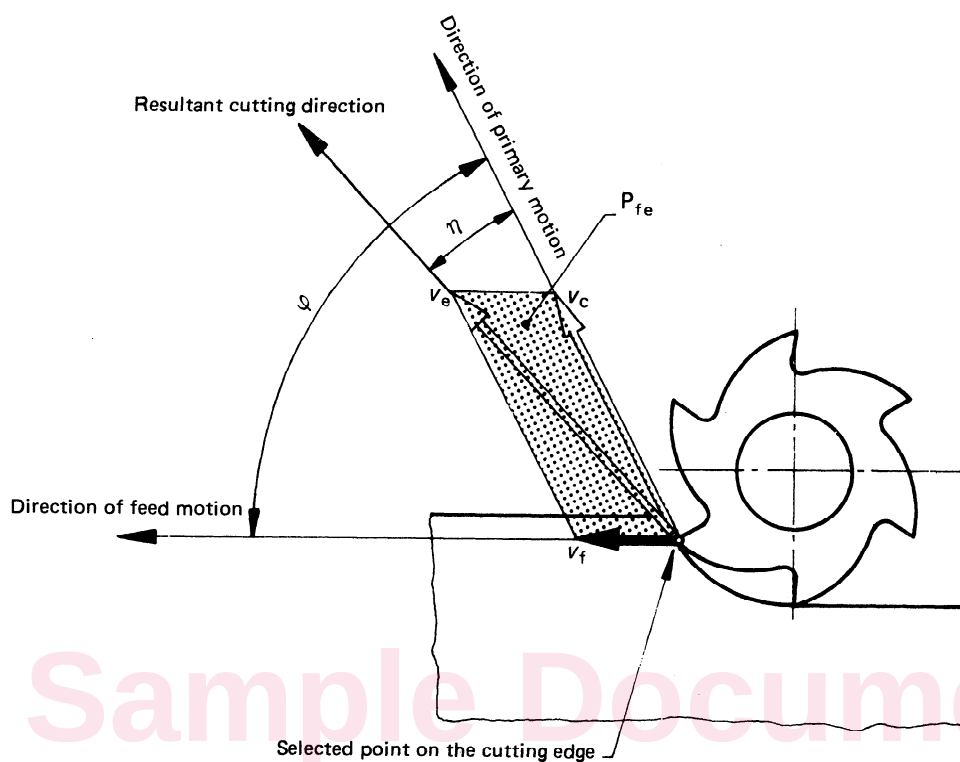


Figure 8 — Tool and workpiece motions — Turning tool



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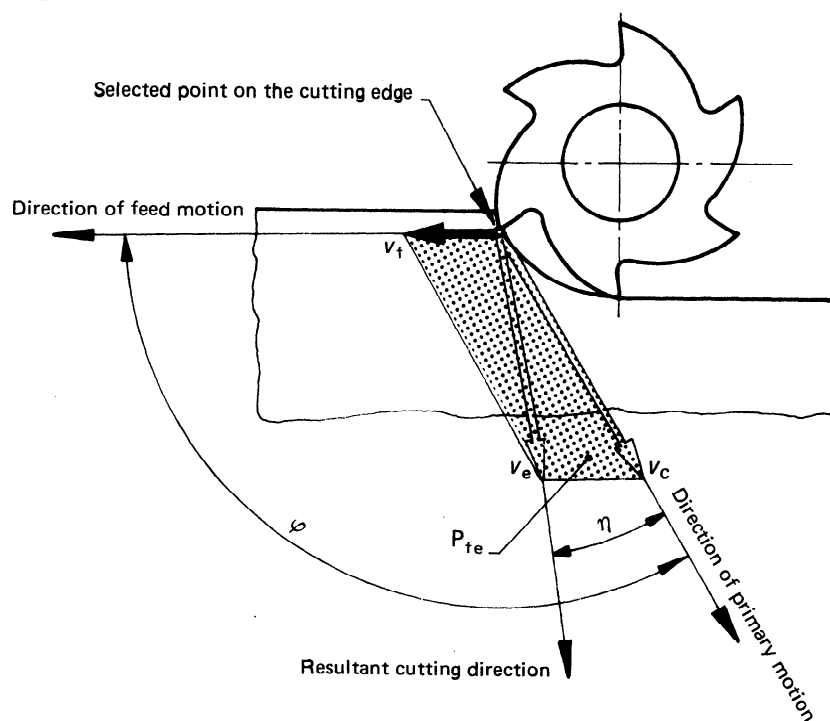


Figure 9 — Tool and workpiece motions — Slab milling cutter

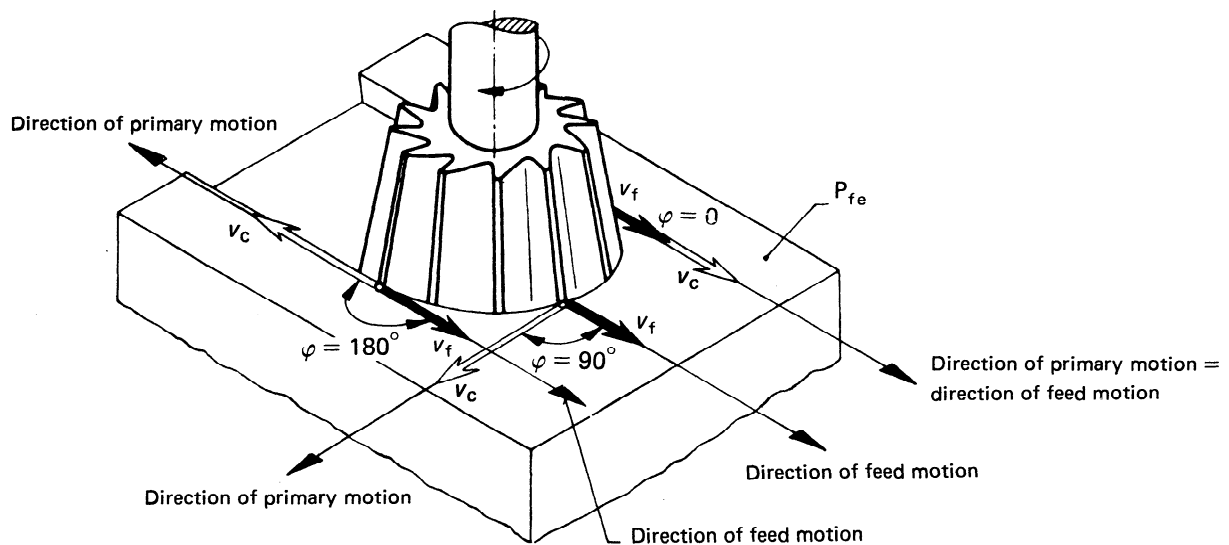


Figure 10 — Tool and workpiece motions considered at three selected points on the cutting edge —
Single angle cutter with parallel shank

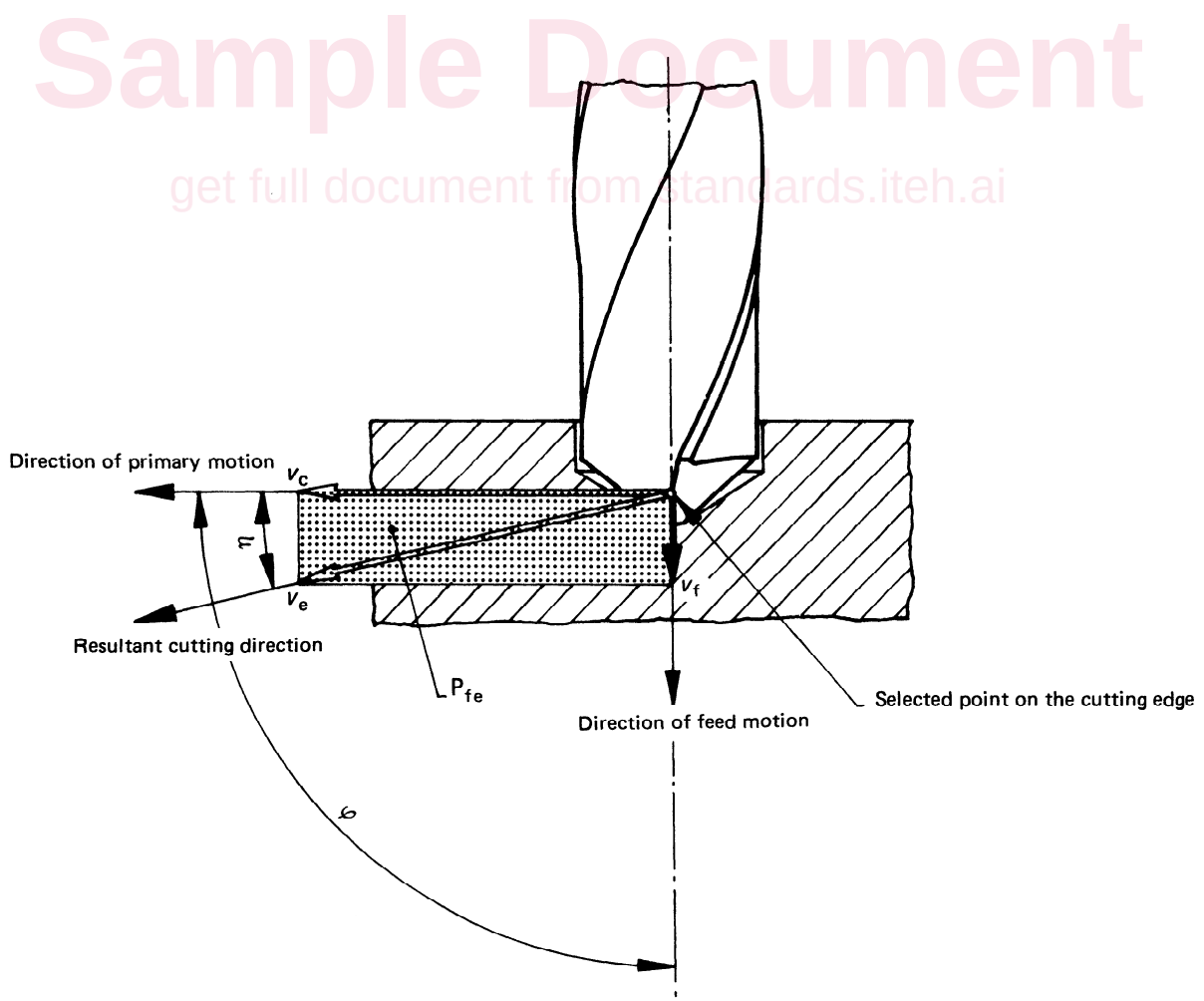


Figure 11 — Tool and workpiece motions — Twist drill