
**Plain bearings — Terms, definitions,
classification and symbols —**

**Part 2:
Friction and wear**

*Paliers lisses — Termes, définitions, classification et symboles —
Partie 2: Frottement et usure*

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 6, *Terms and common items*.

This third edition cancels and replaces the second edition (ISO 4378-2:2009), which has been technically revised. The following changes have been made:

- editorial revision of the document;
- addition of 6 new figures;
- revision of clause numbers.

A list of all the parts in the ISO 4378 series can be found on the ISO website.

Introduction

As there is a large number of multiple designations in the domain of plain bearings, there is a considerable risk of error in the interpretation of standards and technical literature. This uncertainty leads to the continuous addition of supplementary designations, which only serves to increase the misunderstanding.

This document is an attempt to establish a uniform basic system of designations of friction and wear.

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Plain bearings — Terms, definitions, classification and symbols —

Part 2: Friction and wear

1 Scope

This document specifies the most commonly used terms relating to friction and wear of plain bearings with their definitions and classification.

For some terms and word combinations, their short forms are given, which can be used where they are unambiguous. Self-explanatory terms are given without definitions.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 General terms

3.1.1

external friction

force and its phenomenon of resistance to the relative motion between two bodies, originating at the contact area of their surfaces and directed tangentially to them

3.1.2

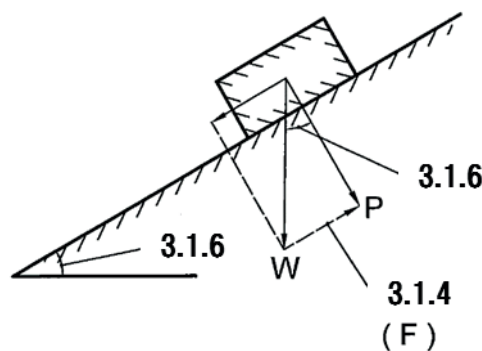
internal friction

force and its phenomenon of resistance to the relative motion of particles or mass of a body with respect to other particles or mass in the same body

3.1.3 friction

force and its phenomenon of resistance to the relative motion working tangentially with respect to the common boundary between two bodies when, under the action of an external force, one body moves or is at rest relative to the surface of the other

Note 1 to entry: See [Figure 1](#).



Key

W weight of material
P normal force
F friction force

Figure 1 — Friction

3.1.4 friction force

force due to *friction* ([3.1.3](#))

Note 1 to entry: See [Figure 1](#).

3.1.5 coefficient of friction

ratio of the *friction force* ([3.1.4](#)) between two bodies to the normal force pressing these bodies together

3.1.6 friction angle

angle, the tangent of which is equal to the ratio of the *friction force* ([3.1.4](#)) to the normal force, or *coefficient of friction* ([3.1.5](#))

Note 1 to entry: See [Figure 1](#).

3.1.7 wear

process of wear or the result of a *wear process* ([3.1.8](#))

3.1.8 wear process

process of a loss of substance from a solid body surface in frictional conditions, which appears as a gradual decrease of body dimensions and/or change of shape

Note 1 to entry: Rarely, in a broader sense, is there a process of permanent increase of body dimensions on the surface without loss of substance.

3.1.9**wear rate**

amount of *wear* (3.1.7) per unit sliding distance or per interval of time

Note 1 to entry: A distinction is made between “momentary” (at a definite moment) and “mean” wear rate (during a definite interval of time).

3.1.10**specific wear rate****wear intensity**

value of amount of *wear* (3.1.7) divided by the product of sliding distance (or time) and load; that is, the ratio of *wear rate* (3.1.9) to the load

Note 1 to entry: Wear can be expressed in the units of length, volume, mass, etc.

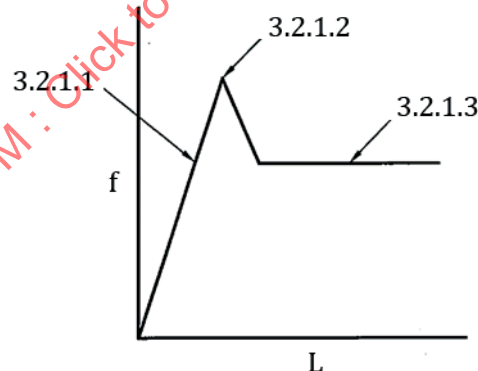
Note 2 to entry: Wear intensity is distinguished as “momentary” or as “mean” wear intensity.

3.2 Types and characteristics of external friction and classification**3.2.1 Classification according to the presence of relative motion****3.2.1.1****static friction**

friction (3.1.3) and its phenomena that occur between two contacting bodies before the start of relative motion under increasing external force

Note 1 to entry: Friction that occurs at an extremely low sliding speed is also referred to as static friction.

Note 2 to entry: See [Figure 2](#).

**Key**

f friction
L sliding distance

Figure 2 — Friction according to relative motion

3.2.1.2**maximum static friction**

friction (3.1.3) and its phenomena that occur between two contacting bodies just before the start of relative motion under gradually increasing external force

Note 1 to entry: See [Figure 2](#).

3.2.1.3

dynamic friction

friction (3.1.3) and its phenomena between two bodies in relative motion

Note 1 to entry: See [Figure 2](#).

3.2.2 Classification according to the mode of relative motion

3.2.2.1

sliding motion

relative motion between two bodies in contact when the contact areas of both bodies move with different magnitudes and/or directions of tangential velocity

3.2.2.2

sliding friction

force and its phenomena of resistance to the *sliding motion* (3.2.2.1) between two bodies

Note 1 to entry: See [Figure 1](#).

3.2.2.3

sliding velocity

difference between tangential velocities of two bodies in contact, at their contact point, during sliding

3.2.2.4

sliding surface

body surface subjected to *sliding motion* (3.2.2.1)

3.2.2.5

rolling motion

relative motion between two bodies in contact when the contact areas of both bodies move with the same magnitude and direction of tangential velocity

3.2.2.6

rolling velocity

revolutional velocity of rolling bodies

3.2.2.7

rolling friction

force and its phenomena of resistance to the *rolling motion* (3.2.2.5) between two bodies

3.2.2.8

combined rolling and sliding friction

dynamic friction (3.2.1.3) that occurs between two contacting bodies when *rolling* and *sliding motion* (3.2.2.1) take place simultaneously within the contact area

3.2.2.9

traction

force and its phenomena that occur during the *rolling motion* (3.2.2.5) of a body on another body, accompanied by sliding at the contact area in the tangential direction, and which are utilized for power transmission

3.2.2.10

traction force

force that occurs during the *rolling motion* (3.2.2.5) of a body on another body, accompanied by sliding at the contact area in the tangential direction

3.2.2.11

coefficient of traction

dimensionless value obtained by dividing the *traction force* (3.2.2.10) by the normal load on the contact area

3.2.3 Classification according to the presence of lubricant

3.2.3.1

unlubricated friction

dry friction

friction (3.1.3) that occurs between two contacting bodies with no lubricant on the interacting surfaces

3.2.3.2

lubricated friction

friction (3.1.3) that occurs between two contacting bodies with a lubricant applied on the interacting surfaces

3.2.3.3

boundary friction

friction (3.1.3) and its phenomena that occur in a boundary lubrication condition

3.2.3.4

mixed friction

friction (3.1.3) and its phenomena that occur in a mixed-film lubrication

3.2.3.5

fluid friction

friction (3.1.3) and its phenomena of resistance to the relative motion between individual molecules of the fluid or between the fluid and the wall of the container

3.3 Types and characteristics of wear process and classification

3.3.1 Mechanical wear

3.3.1.1

mechanical wear

wear process (3.1.8) due to mechanical actions

3.3.1.2

abrasive wear

wear process (3.1.8) of a material caused by cutting or scratching actions of hard bodies or hard particles

Note 1 to entry: See [Figure 3](#).

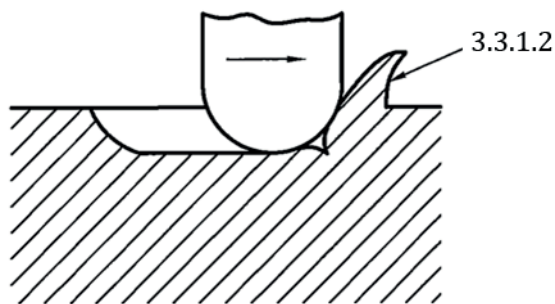


Figure 3 — Abrasive wear

3.3.1.3

adhesive wear

wear process (3.1.8) due to adhesion and extraction of material out of the body surface

Note 1 to entry: See [Figure 4](#).

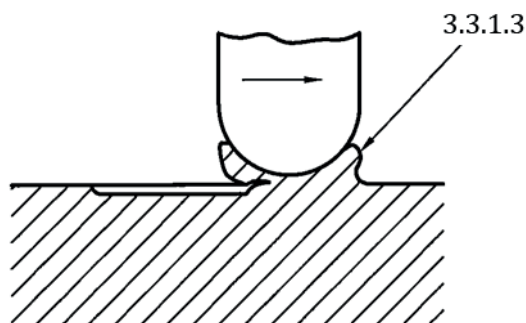


Figure 4 — Adhesive wear

3.3.1.4

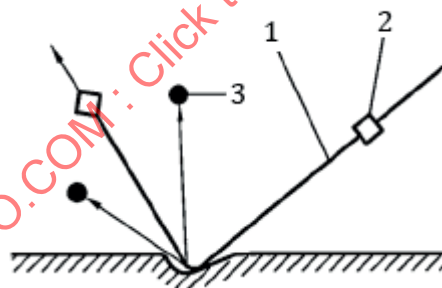
hydro-abrasive wear

fluid-abrasive wear

wear process (3.1.8) due to the action of hard bodies or hard particles carried in a flowing liquid or gas

Note 1 to entry: Hydro-abrasive wear is also known as gas-abrasive wear.

Note 2 to entry: See [Figure 5](#).



Key

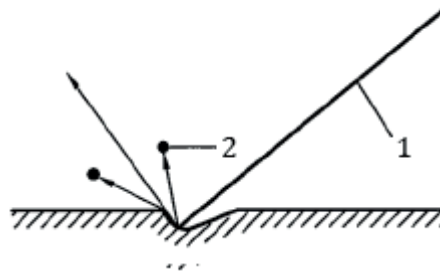
- 1 flowing liquid or gas
- 2 hard particles
- 3 wear debris

Figure 5 — Hydro abrasive wear

3.3.1.5**fluid erosion**

wear process (3.1.8) due to the action of streaming liquid or gas

Note 1 to entry: See [Figure 6](#).

**Key**

- 1 streaming liquid or gas
- 2 wear debris

Figure 6 — Fluid erosion

3.3.1.6**fatigue wear**

wear process (3.1.8) caused by fatigue fracture when micro volumes of the frictional surface material are subjected to repeated stress

Note 1 to entry: Fatigue wear may occur during both sliding and rolling.

3.3.1.7**cavitation wear****cavitation erosion**

wear process (3.1.8) when liquid moves along a solid wall or when a solid body moves relatively with respect to liquid in which vapour bubbles generated by reduction of pressure collapse close to the surface, thus, causing locally high impact pressure or high temperature

3.3.1.8**fretting wear**

wear process (3.1.8) of the contacting bodies under a condition of oscillatory relative micro-displacement

3.3.2 Mechano-chemical wear**3.3.2.1****mechano-chemical wear****tribo-chemical wear**

wear process (3.1.8) due to mechanical action accompanied by chemical and/or electrochemical interaction of the material with the environment

3.3.2.2**fretting corrosion**

mechanical and chemical *wear process* (3.1.8) of the contacting bodies under a condition of oscillatory relative micro-displacement

Note 1 to entry: In case of ferrous materials under lubricated conditions, brownish oxidative wear particles are generated.

3.3.2.3

oxidative wear

wear process (3.1.8) in which chemical reaction of material with oxygen or oxidizing media predominates

3.3.3 Other wear

3.3.3.1

electroerosive wear

wear process (3.1.8) caused by electrical discharge that occurs at the contact surfaces of two bodies when electric current flows between them

3.3.3.2

thermal wear

wear due to softening and melting of the friction area caused by the heating of the surroundings and *friction* (3.1.3)

3.4 Phenomena and processes in friction and wear

3.4.1

stick-slip motion

phenomenon of alternation of relative sliding and relative state of rest or alternately increasing and decreasing relative *sliding velocity* (3.2.2.3) developing spontaneously during *dynamic friction* (3.2.1.3)

Note 1 to entry: As an example of stick-slip motion, self-excited vibration occurs when the friction coefficient decreases with the increase of relative sliding velocity.

3.4.2

adhesion in friction

adhesion

phenomenon of local attraction of two bodies in relative sliding due to the action of molecular forces

3.4.3

transfer of material

phenomenon developed during *friction* (3.1.3) when the material of one body adheres to another body and, being detached from the first, remains on the surface of the second body

3.4.4

seizure

process of formation and developing of damage on *sliding surfaces* (3.2.2.4) due to *adhesion* (3.4.2) and *transfer of material* (3.4.3)

Note 1 to entry: Seizure may result in rapid stopping of relative motion.

3.4.5

fatigue

damage and fracture due to the repetition of stress produced by external load

3.4.6

scoring

damage of surface(s) in relative sliding in the form of severe scratches in the direction of sliding

3.4.7

scratching

formation of fine scratches on the surface in the direction of sliding due to irregularities on the harder *sliding surface* (3.2.2.4) or due to hard particles