भारतीय मानक
Indian Standard

IS 10260 (Part 2) : 2024
ISO 4378-2 : 2017

प्लेन बियरिंग्स — शब्दावली, परिभाषाएँ, वर्गीकरण और चिह्न

भाग 2 घर्षण और घिसाव

(दूसरा पुनरीक्षण)

Plain Bearings — Terms, Definitions, Classification and Symbols

Part 2 Friction and Wear

(Second Revision)

ICS 01.040.21; 21.100.10

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Bearings Sectional Committee, PGD 13

NATIONAL FOREWORD

This Indian Standard (Part 2) (Second Revision) which is identical to ISO 4378-2 : 2017 'Plain bearings — Terms, definitions, classification and symbols — Part 2: Friction and wear' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Bearings Sectional Committee and approval of the Production and General Engineering Division Council.

This standard was first published in 1982 and subsequently revised in 2017. First revision was based on ISO 4378-2 : 2009 'Plain bearings — Terms, definitions, classification and symbols — Part 2: Friction and wear', issued by the International Organization for Standardization (ISO). This revision has been undertaken to align it with ISO 4378-2 : 2017.

The major changes have been incorporated in this revision are as follows:

a) Thorough editorial revision of the standard has been done;
b) Six new figures have been added; and
c) Clause numbers of the standard have been revised.

This standard has been published in five parts. Other parts in this series are:

Part 1 Design, bearing materials and their properties
Part 3 Lubrication
Part 4 Basic symbols
Part 5 Application of symbols

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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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.

Indian Standard

PLAIN BEARINGS — TERMS, DEFINITIONS, CLASSIFICATION AND SYMBOLS

PART 2 FRICTION AND WEAR

(Second Revision)

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

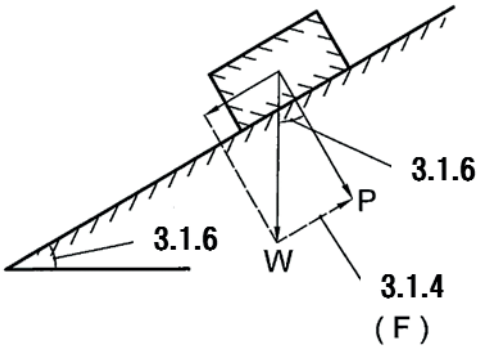
3.1 General terms

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.

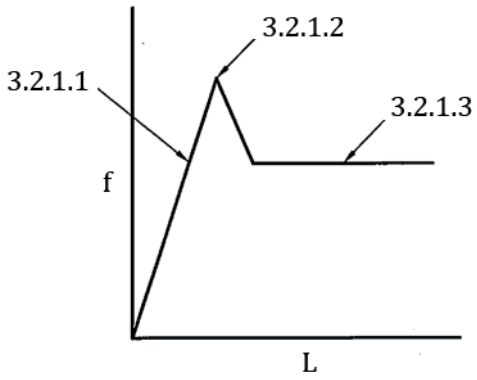
3.2 Types and characteristics of external friction and classification

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.

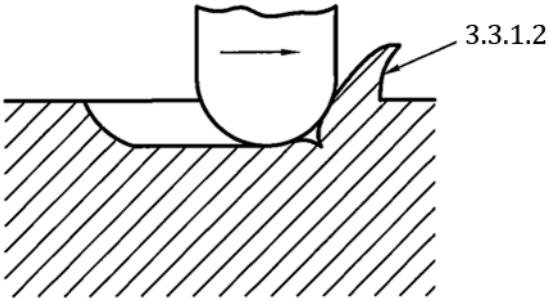


Figure 3 — Abrasive wear

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.

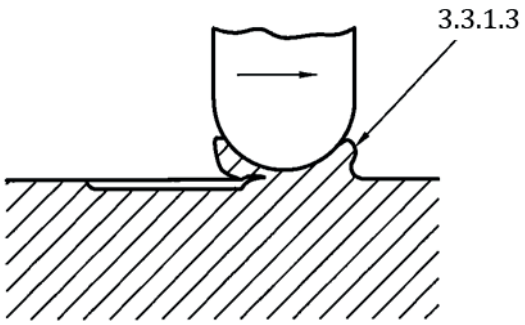
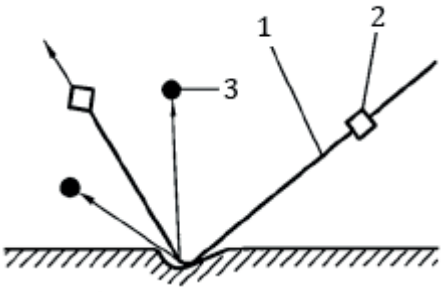


Figure 4 — Adhesive wear

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.

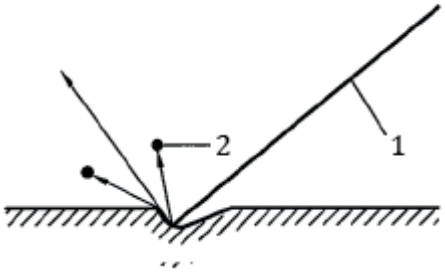


Key
1 flowing liquid or gas
2 hard particles
3 wear debris

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

3.4.8
spalling
flaking
separation of material from a surface in the form of flakes due to *fatigue wear* (3.3.1.6)

Note 1 to entry: This phenomenon is observed mainly in rolling bearings and gears.

3.4.9
pitting
process of pit formation on the surface(s) in relative sliding due to detaching of particles of material during *fatigue wear* (3.3.1.6)

Note 1 to entry: This phenomenon is observed mainly in rolling bearings and gears.

3.4.10
running-in
process of changing the geometry of surface(s) in relative sliding as well as physical and mechanical properties of material surface layers during the initial period of *friction* (3.1.3) usually displayed as decrease of *friction force* (3.1.4), temperature and *wear intensity* (3.1.10) under constant outside conditions

3.4.11
initial running-in
running-in (3.4.10) that occurs in the initial stage of a running-in period

3.4.12
edge loading
condition in which the shaft and the bearing come extremely close to, or in contact with, each other at an end or both ends of the bearing due to bending or tilting of the shaft or improper installation of the bearing and in which brinelling or wear occurs on the bearing as a result

3.5 Vibration and vibration-related terms regarding a rotating shaft supported by plain bearings

3.5.1
oil whip
phenomenon of the static equilibrium state of an elastic rotating shaft supported by journal bearings becoming unstable when the rotational speed exceeds the limit speed determined by the characteristics of lubricant film force, the shaft weight and the rigidity of bending of the shaft, which starts a whirling motion at high amplitude at the frequency closely corresponding to the minimum bending frequency

Note 1 to entry: This phenomenon leads to catastrophic breakdown of machines.

3.5.2
oil whirl
phenomenon of the static equilibrium state of a rigid rotating shaft supported by journal bearings becoming unstable and starting a whirling motion at a frequency corresponding to a little less than half of the rotational speed, ω, when the rotational speed exceeds the limit speed determined by the characteristics of lubricant film force and the shaft weight

3.5.3
friction whirl
phenomenon of a rotating shaft making a whirling motion in a journal bearing while intermittently making solid contact

3.5.4
stiffness coefficient of lubricant film
spring constant of lubricant film in a journal bearing, determined by the ratio of increase of lubricant film force with the increase of displacement of the shaft centre

3.5.5
damping coefficient of lubricant film
damping constant of lubricant film in a journal bearing, determined by the ratio of increase of lubricant film force with the increase of velocity of the shaft centre

3.5.6
creep of bearing
phenomenon of the plain bearing under rotating load sliding slowly in the housing in the opposite direction to that of shaft rotation, resulting in damage such as *wear* (3.1.7), *seizure* (3.4.4) or deformation on the fitting surfaces

Bureau of Indian Standards

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Review of Indian Standards

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Amendments Issued Since Publication

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