



# Plain bearings — Testing of the tribological behaviour of plastics

*Paliers lisses — Essai du comportement tribologique des plastiques*

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ISO/TR 7147 was prepared by Technical Committee ISO/TC 123, *Plain bearings*.

The reasons which led to the decision to publish this document in the form of a technical report type 2 are explained in the Introduction.

## 0 Introduction

As several research institutes are still carrying out tests on the tribological behaviour of plastics for plain bearings and, consequently, results are not yet available, it has been decided, for the time being, to publish work on the test system in the form of a Technical Report.

When the test results from the different institutes are available, the status of this Technical Report will be re-assessed.

## 1 Scope and field of application

This Technical Report specifies uniform instructions for the testing of tribologically-stressed plain bearing elements manufactured from solid plastics.

The test values will give useful information for practical application only if all parameters of influence are identical.

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**Descriptors:** bearings, plain bearings, plastics, tests, friction tests, wear tests.

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The purpose of this Technical Report is to obtain, under specified and exactly defined operating conditions, reproducible measured values for wear and the coefficient of friction as regards plastics/steel or plastics/plastics sliding couples. Consequently, to obtain comparability of these values, exact indications are necessary concerning directly acting influences, such as the form of the specimen, the condition of surface and material or the sliding couple. This Technical Report, therefore, defines the forms that test specimens shall take and specifies uniform manufacturing processes for the test specimens. In order also to eliminate the secondary influences created by the nature of the test system (e.g. conditions of thermal conduction, vibrations, driving vibrations, mounting conditions) the complete test equipment and basic construction and performance requirements have also been standardized.

## 2 References

ISO 291, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 527, *Plastics — Determination of tensile properties.*<sup>1)</sup>

ISO 4378, *Plain bearings; Terms, definitions and classification —*

*Part 1: Design, bearing materials and their properties.*

*Part 2: Friction and wear.*

*Part 3: Lubrication.*

ISO 6691, *Plain bearings — Thermoplastics — Classification, designation, recommendations.*<sup>2)</sup>

## 3 Symbols

|           |                                                             |
|-----------|-------------------------------------------------------------|
| $A_0$     | nominal contact surface, in square millimetres              |
| $f$       | coefficient of friction                                     |
| $F_n$     | normal force, in newtons                                    |
| $F_f$     | friction force, in newtons                                  |
| $k$       | wear coefficient, in cubic millimetres per newton kilometre |
| $p$       | nominal specific load, in newtons per square millimetre     |
| $r_g$     | mean radius of sliding way, in millimetres                  |
| $s$       | sliding distance, in kilometres                             |
| $t_d$     | temperature of the disc, in degrees Celsius                 |
| $u$       | sliding velocity, in metres per second                      |
| $w_l$     | linear wear of test material, in micrometres                |
| $w_v$     | volumetric wear of test material, in cubic millimetres      |
| $w_{l/s}$ | linear wear rate, in micrometres per kilometre              |
| $w_{v/s}$ | volumetric wear rate, in cubic millimetres per kilometre    |

## 4 Definitions

**4.1 dry friction:** Condition of friction where two initially degreased and cleaned sliding surfaces are in contact with each other without external lubrication.

**4.2 coefficient of friction:** Ratio of the friction force between two bodies to the normal force pressing these bodies together, i.e.:

$$f = \frac{F_f}{F_n}$$

**4.3 wear rate:** The linear or volumetric wear of the test material referred to the sliding distance, i.e.:

$$w_{l/s} = \frac{w_l}{s} \text{ or } w_{v/s} = \frac{w_v}{s}$$

1) At present at the stage of draft. (Revision of ISO/R 527-1966.)

2) At present at the stage of draft.

**4.4 wear coefficient:** The linear wear rate referred to the nominal specific load or volumetric wear rate referred to the normal force, i.e.:

$$k = \frac{w_{l/s}}{p} \times 10^{-3} = \frac{w_{v/s}}{F_n} \times 10^{-3}$$

## 5 Form and manufacture of the test specimen

For the testing of plastics in accordance with this Technical Report, the sliding couple shall consist of two test specimens, i.e. a pin and a disc. As to the material, in principle, the possible mating combinations are as given in the table.

**Table — Mating combinations**

| Mating combination | Sliding couple |          |
|--------------------|----------------|----------|
|                    | Pin            | Disc     |
| I                  | Plastics       | Metal    |
| II                 | Metal          | Plastics |
| III                | Plastics       | Plastics |

The basic mating combination according to this Technical Report is combination I.

### 5.1 Pin

The pin shall have a diameter of 3 mm a length of 10 mm (see figure 1).

It can be made by moulding, injection moulding or by cutting an extruded bar to length or by machining it all over. As the structural condition of the plastic pin constitutes an important factor as far as the reproducibility of the test results are concerned, it is necessary to know the following information:

- the method of manufacture;
- the condition of the structure (e.g. skin of injection moulding, degree of crystallinity);
- the surface hardness;
- the state of conditioning (e.g. moisture content).

These details may be omitted if one of the following methods is used for the manufacture of the pin:

- by machining the pin out of a standard tension bar in accordance with ISO 527 [see figure 2a)];
- by taking the pin out of an existing sliding element [see figure 2b)];
- by manufacturing the pin out of semi-finished materials from which the sliding elements are made [see figure 2c)].

For the treatment of the machined pin, the maximum surface roughness shall be in accordance with the requirements of figure 1.

### 5.2 Disc

Discs in accordance with this Technical Report are defined as steel rings with the dimensions as given in figure 3. The basic form of these discs is identical to the raceways of deep groove ball thrust bearings. The surface which is intended to be the sliding surface shall be made in accordance with figure 3.

Rolling bearing steel 100 C6 shall be used as material. If other materials are used the following details shall be given:

- material specification, composition and condition of structure;
- surface condition (manufacturing process, roughness, hardness).

Dimensions in millimetres

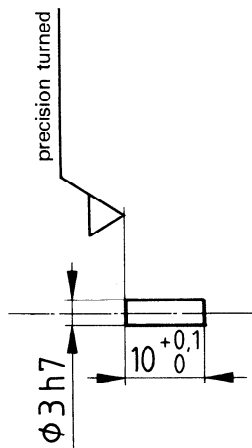
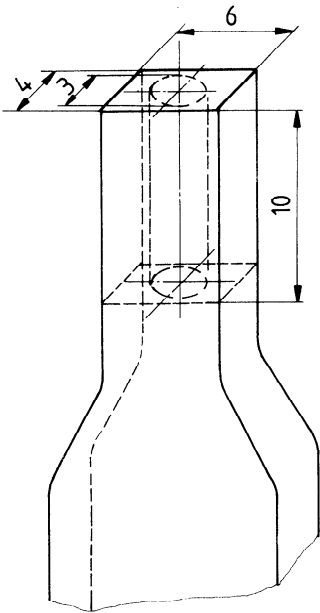


Figure 1 — Test specimen — Pin

Dimensions in millimetres



a) from a standard tension bar

Dimensions in millimetres

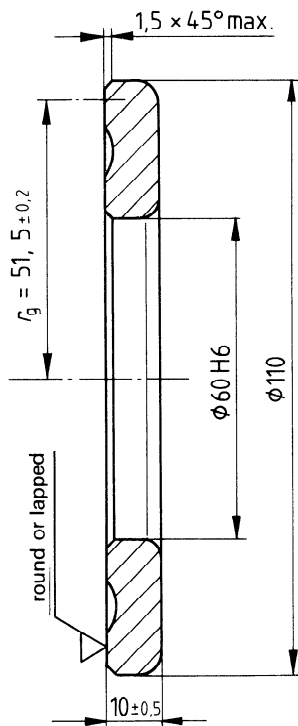
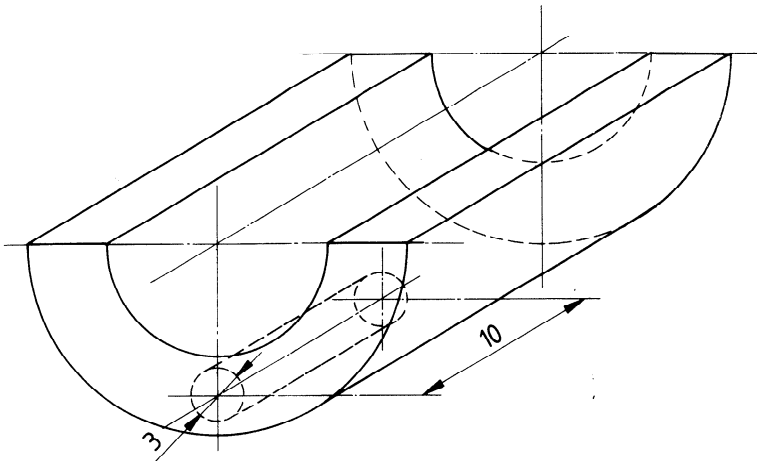
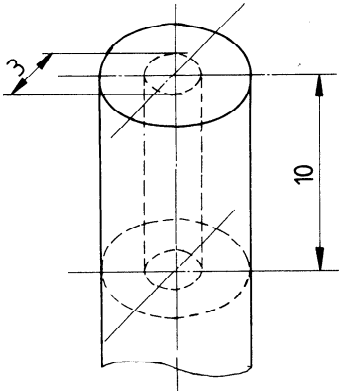


Figure 3 — Test specimen — Disc



b) from an existing sliding element



c) from semi-finished material

Figure 2 — Machining of the pin