FINAL DRAFT

INTERNATIONAL STANDARD

ISO/FDIS 21866-1

ISO/TC **123**/SC **2**

Secretariat: DIN

Voting begins on:
2020-04-23

Voting terminates on:
2020-06-18

Plain bearings — Automotive engine bearing test rig using actual connecting rods —

Part 1: Test rig

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

Reference number
ISO/FDIS 21866-1:2020(E)

Contents

Page

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions*.

A list of all parts in the ISO 21866 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Recently, the rigidity of automotive engine bearings and their housings have been lowered due to the demand for weight reduction, and they are getting easier to be deformed. On the other hand, for achieving clean combustion with high heat efficiency, combustion pressure and bearing oil film pressure have become higher. Also, the minimum oil film thickness for bearing has been made thinner by using low-viscosity oil to reduce friction loss. The plain bearings for automotive engines have a tough situation because of all these changes.

So far, the test rig used for plain bearings has been developed with the application of elasto-hydrodynamic lubrication theory (EHL). But the serious problem stated above remains: the rigidity of a connecting rod bearing for automotive engine is lowered in comparison with other machineries because of the especial requirement of weight reduction.

Based on the abovementioned background, it is essential to evaluate the bearings for each car, using the actual engines. Also, not only the magnitude and pattern of the load on a bearing but also the engine speed are different between gasoline engine bearings and diesel engine bearings, so the different bearings need to be developed accordingly. As a consequence, it has become essential to conduct a final test with the engine of an actual car because the conventional test rig could not meet such requirements.

The aim of this document is to shorten the time and reduce the costs needed on engine bearing testing in order to satisfy the requirements of automotive engine bearings at present and in future by using connecting rods of actual cars.

Plain bearings — Automotive engine bearing test rig using actual connecting rods —

Part 1:
Test rig

1 Scope

This document specifies the requirements for an engine bearing test rig that uses an actual connecting rod to determine plain bearing performance in automotive engines, evaluating fundamental bearing properties such as seizure resistance, wear resistance, fatigue resistance and resistance to the impact of foreign material.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4378-1, *Plain bearings — Terms, definitions, classification and symbols — Part 1: Design, bearing materials and their properties*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4378-1 apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Classification of bearing tests

Three stages of functional evaluation test methods of plain bearings using various kinds of test rigs are shown in Table 1.

Table 1 — Examples of stages for bearing evaluation tests

Stage	Purpose	Bearing housing	Test method
Stage 1	screening of material properties	—	— pin on disc — block on ring — other
Stage 2	evaluation of the bearing function	high rigidity connecting rod connecting rod similar to the actual connecting rod	own test rig by bearing manufacturer
Stage 3	validation of the actual engine	actual connecting rod	— actual engine — actual car

At stage 1, primary screening is conducted at the earliest stage of bearing material development, selection or evaluation using fundamental test rigs such as pin on disc or block on ring.

At stage 2, the tests are conducted to evaluate the bearing material and design, using an actual plain bearing constructed from material that has shown excellent performance during stage 1 testing. In this stage, the operating conditions and assessment procedure provided in ISO 6281 are considered. Test rigs appropriate for each testing purpose are used and the damage of the bearing is judged as described in ISO 7146-1 and ISO 7146-2.

At stage 3, engine or vehicle testing of the actual bearing that has passed stage 2 is conducted as the final verification before market launch.

Unexpected bearing damage can occasionally occur due to differences between actual application operating conditions and test conditions at stage 2 and stage 3. Rectification late in the product development timeframe can incur expense and delay. Therefore, it is imperative to develop an alternative, more effective evaluation method at stage 2 and stage 3 by using an actual connecting rod to improve the reliability of automotive engine bearings.

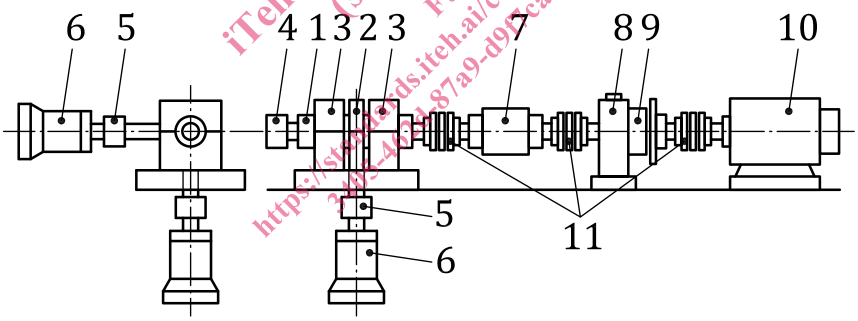
Examples of bearing seizure and fatigue tests using the test rigs specified in this document are shown in Annex A and Annex B.

It is important to understand that connecting rod rigidity affects the housing deformation and oil pressure distribution. For information, an example of the oil film calculation is shown in Annex C.

5 Test rig

5.1 Test rig construction

Figure 1 shows an example of the overall configuration of the test rig.



Key

1 test shaft
2 test connecting rod
3 support bearing housing
4 oil feed equipment
5 load cell
6 dynamic servo actuator
7 torque metre
8 gear box
9 torque limit clutch
10 drive motor
11 flexible coupling

Figure 1 — Overview of bearing test rig construction

One particular test rig that meets the requirements mentioned in the scope is described as follows.

To emulate mechanical conditions within the engine, an actual connecting rod is used. The test bearing is assembled into the big end or small end of the connecting rod, and a dynamic load is applied. Figure 1 shows the overall structure of the test rig. A test bearing in the test connecting rod (2) is mounted on the test shaft (1) which is driven by a speed-variable motor (10) via a torque metre (7) and a torque limit clutch (9). Friction of the test bearing is measured by the torque metre and the test rig is protected from damage due to bearing failure by an emergency stop. A servo actuator (6) is capable of producing dynamic loads with a frequency higher than the engine speed, measured by load cell (5). Oil is supplied to the test bearing in the test connecting rod (2) by the oil supply equipment (4) to simulate the oil supply through engine crankshaft. The dynamic load pattern is synchronized to the shaft oil-hole pattern. Stable temperature measurement of the test bearing is shown in Figure 7, accomplished by the constant pressure on the thermocouple to maintain contact with the bearing back. Figure 8 shows that the test rig is able to measure the effects of axial misalignment on bearing back temperature.

Dimensions and rigidity of the test connecting rod assembly components may be freely chosen within an appropriate range. Dynamic load elements that may be freely chosen within an appropriate range are wave form, amplitude, frequency and stopped load step magnitude. Examples of variables that are related to bearing properties to be measured during testing are temperature, bearing hardness, polishing method, bearing geometry (roundness, roughness, waviness, concavity and straightness), lubricant viscosity and lubricant additives. These variables may be specified within an appropriate range. Several bearing properties may be tested concurrently.

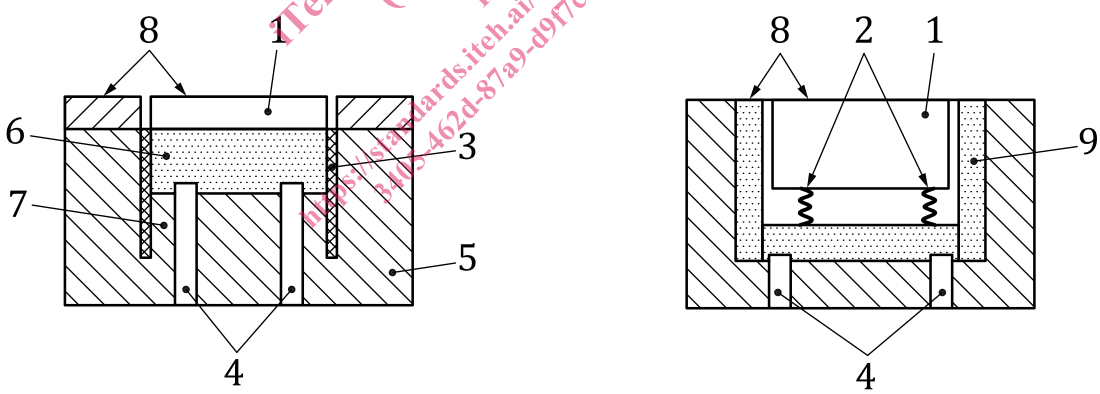
5.2 Rig frame construction

When the bearing is tested under a dynamic load, it is important to avoid the resonant vibrations of the test rig frame. The resonance frequency of the test rig frame shall be higher than the dynamic load frequency.

5.3 Foundation structure

It is necessary to pay attention to the structure and weight of the foundation for the test rig in order to ensure the reliability of the test.

Figure 2 shows two types of foundation for the test rig.



a) Edge cutting foundation **b) Floating foundation**

Key

1 surface plate mass
2 damper spring
3 separator filler
4 construction anchor pile
5 ground
6 concrete mass
7 ground mass
8 floor
9 concrete sand stopper

Figure 2 — Examples of the foundation for a test rig

In Figure 2, a), a separator filler (3) is provided around the surface plate mass (1) and the concrete mass (6) in order to cut off the vibration from the floor. In Figure 2, b), the surface plate mass (1) is supported by damper springs (2) which cut off the vibration. Generally, Figure 2, b) shows an excellent vibration isolation performance while Figure 2, a) can reduce the expense.

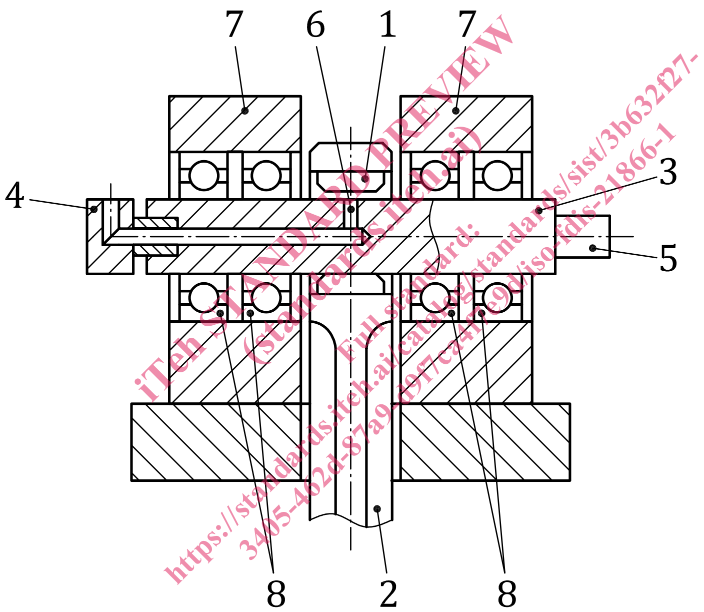
In Figure 2, a), the foundation weight is the total weight of (1), (6) and (7). In Figure 2, b), it is the weight of (1). In both types, the foundation weight should be 10 times to 20 times heavier than the maximum vibration load given as the product of maximum acceleration and accelerated mass.

5.4 Test using actual engine connecting rod

5.4.1 Structure around the test bearing

Figure 3 shows the structure of the main part of the test rig in which the test bearing and the test shaft are installed.

As mentioned in Clause 4 and illustrated in Figure 3, the test bearing (1) in the connecting rod (2) is mounted on the rotating test shaft (3) which is supported by support bearings (8) and the housings (7). Lubricating oil is supplied to the test bearing (1) through oil supply equipment (4) and an oil supply hole (6), simulating an actual crankshaft.



Key

1	test bearing	5	connecting shaft to coupling
2	connecting rod	6	oil supply hole
3	test shaft	7	housing
4	oil supply equipment	8	support bearing

Figure 3 — Test section and the support bearing

5.4.2 Structure around the support bearing

Figure 4 shows three types of support bearings: a) rolling bearings, b) plain bearings and c) plain bearings with a cylindrical sleeve mounted in a housing for rolling bearings.

