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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

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**Plain bearings - Automotive engine bearing test rig using actual
connecting rods - Part 1: Test rig**

滑动轴承 使用实际连杆汽车发动机轴承试验台 第1部分：试验台

(English Translation)

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1 Scope

This document specifies the requirements for engine bearing test rigs. These rigs utilize actual connecting rods to evaluate the essential performance characteristics of plain bearings used in automotive engines, such as seizure resistance, wear resistance, fatigue resistance, and resistance to foreign object impact.

This document is applicable to the performance evaluation of bearings using actual connecting rods.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through normative references in the text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

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

NOTE: GB/T 2889.1-2020 Plain bearings - Terms, definitions, classification and symbols - Part 1.

Design, bearing materials and their properties (ISO 4378-1.2017, IDT)

3 Terms and Definitions

The terms and definitions defined in ISO 4378-1 are applicable to this document.

4 Classification of Bearing Tests

Table 1 outlines the three stages of functional assessment test methods for plain bearings across various types of test rigs.

Table 1 -- Examples of Bearing Assessment Test Stages

In Stage 1-the initial phase of bearing material development, selection, or assessment-basic testing equipment such as pin-on-disk or block-on-ring testers is used for preliminary screening.

In Stage 2, plain bearings manufactured from materials that demonstrated excellent performance in Stage 1 tests are tested to assess both the materials and the bearing design. At this stage, the operating conditions and assessment procedures specified in ISO 6281 are taken into account. Use a test rig suitable for each test objective and evaluate bearing damage in accordance with the provisions of ISO 7146-1 and ISO 7146-2.

In Stage 3, actual bearings that have passed Stage 2 undergo engine or vehicle testing as a final validation step prior to market release.

Unexpected bearing damage can occasionally occur due to discrepancies between the operating conditions in actual applications and the testing conditions used in Stages 2 and 3. Product improvements made during the late stages of product development can lead to delays and additional costs. Therefore, there is an urgent need to develop a more effective assessment method using actual connecting rods in Stages 2 and 3 to enhance the reliability of automotive engine bearings.

Examples of conducting bearing seizure and fatigue tests using the test rig specified in this document are provided in Appendix A and Appendix B.

Connecting rod stiffness significantly influences bearing housing deformation and oil film pressure distribution. Examples of information regarding oil film calculations are provided in Appendix C.

5.1 Test Rig Structure

Figure 1 shows a schematic diagram of the bearing test rig structure.

Explanation of indexing numbers.

1 -- Test shaft;

2 -- Test connecting rod;

- 3 -- Support bearing housing;
- 4 -- Oil supply system;
- 5 -- Force sensor;
- 6 -- Dynamic servo actuator;
- 7 -- Torque sensor;
- 8 -- Gearbox;
- 9 -- Torque-limiting clutch;
- 10 -- Drive motor;
- 11 -- Flexible coupling.

Figure 1 -- Schematic Diagram of the Bearing Test Rig Structure

The specific test rig meeting the requirements of the scope is described below.

An actual connecting rod is used to simulate operating conditions within the engine. The test bearing is mounted on the big or small end of the connecting rod, and a dynamic load is applied.

Figure 1 illustrates the overall structure of the test rig. The test bearing, housed within the test connecting rod (2), is mounted on the test shaft (1); this shaft is driven by a drive motor (10) via a torque sensor (7) and a torque-limiting clutch (9). Friction in the test bearing is measured using the torque sensor, and an emergency stop device protects the test rig from damage caused by bearing failure. The dynamic servo actuator (6) is capable of generating dynamic loads at frequencies higher than the engine speed. The oil supply system (4) supplies oil to the test bearing within the test connecting rod (2), simulating the oil supply delivered through an engine crankshaft. The dynamic load mode is synchronized with the shaft oil hole position. The measurement of the bearing's stable temperature is shown in Figure 7; contact between the thermocouple and the back of the bearing shell is maintained by applying constant pressure to the thermocouple.

The measurement of the test bearing's stable temperature is shown in Figure 7; contact between the thermocouple and the bearing backing is maintained by applying constant pressure to the thermocouple. Figure 8 illustrates that the test rig is capable of measuring the effect of axial misalignment on bearing backing temperature.

The dimensions and stiffness of the test connecting rod assembly can be freely selected within appropriate ranges. Other dynamic load parameters that can be freely selected within appropriate ranges include waveform, amplitude, frequency, and load step size. Examples of variables related to bearing performance during testing include temperature, bearing hardness, polishing methods, bearing geometry (roundness, roughness, waviness, concavity, and straightness), lubricant viscosity, and additives. These variables can be

specified within appropriate ranges, allowing for the simultaneous testing of multiple bearing performance characteristics.

5.2 Test Rig Frame Structure

When testing bearings under dynamic loads, it is crucial to avoid resonance in the test rig frame.

The resonant frequency of the test rig frame shall be higher than the frequency of the dynamic load. Examples of calculated resonant frequencies based on frame type are provided in

Appendix D.

5.3 Foundation Structure

To ensure the reliability of the test, the structure and mass of the test rig foundation must be considered.

Figure 2 illustrates two types of foundation structures for the test rig.

8 -- Equipment mounting surface;

9 -- Concrete sand barrier.

Figure 2 -- Examples of Test Rig Foundations

In Figure 2a), isolation filler (3) is packed around the panel (1) and the concrete (6) to decouple floor vibrations. In Figure 2b), the panel (1) is supported by vibration-damping springs (2), which isolate vibrations. Generally, the configuration in Figure 2b) offers superior vibration isolation, whereas the configuration in Figure 2a) allows for lower costs.

In Figure 2a), the foundation mass is the combined mass of (1), (6), and (7). In Figure 2b), it is the mass of (1) alone. For both structures, the foundation mass should ideally be 10 to 20 times greater than the maximum vibration load, calculated as the product of the maximum acceleration and the accelerated mass.

5.4.1 Structure around the test bearing

Figure 3 illustrates the structure of the test rig's main components, including the test bearing and the test shaft.

As described in Clause 4 and shown in Figure 3, the test bearing (1) located in the connecting rod (2) is mounted on a rotating test shaft (3) supported by support bearings (8) and bearing housings (7). Lubricating oil is supplied to the test bearing (1) via the oil supply unit (4) and the oil supply hole (6), simulating an actual crankshaft.

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