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JIS B 1081 : 1997

(ISO 3800 : 1993)

**Threaded fasteners—
Axial load fatigue testing—
Test methods and evaluation
of results**

ICS 21.040.01

Descriptors : threads, threaded fasteners, fatigue testing, tensile testing

Reference number : JIS B 1081 : 1997 (E)

B 1081 : 1997 (ISO 3800 : 1993)

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS B 1081 : 1991** is replaced with **JIS B 1081 : 1997**.

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Threaded fasteners— Axial load fatigue testing— Test methods and evaluation of results

Introduction This Japanese Industrial Standard has been prepared based on ISO 3800, *Threaded fasteners—Axial load fatigue testing—Test methods and evaluation of results* issued in 1993 as the first edition without changing the technical contents.

The “Remarks” and “Informative references” underlined with dots in this Standard are the matters not included in the original International Standard.

1 Scope This Japanese Industrial Standard specifies the conditions for carrying out axial load fatigue tests on threaded fasteners, as well as recommendations for the evaluation of the results.

Unless otherwise agreed, the tests are of the fluctuating tension type and are carried out at room temperature, the loading applied being centric along the longitudinal axis of the fastener. The influence of the compliance of clamped parts on the strain of the fastener is not taken into account.

This method allows determination of the fatigue strength of threaded fasteners.

The test results can be influenced by the test conditions. For this reason, minimum requirements are specified to reduce this effect. In addition, calibration and centering control methods for the testing apparatus are included.

Remarks : The International Standard corresponding to this Standard is as follows.

ISO 3800 : 1993 *Threaded fasteners—Axial load fatigue testing—Test methods and evaluation of results*

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards indicated below shall be applied.

JIS B 1001 *Diameter of clearance holes and counterbores for bolts and screws*

Remarks : The provisions cited from ISO 273 : 1979, *Fasteners—Clearance holes for bolts and screws* are equivalent to the corresponding provisions in the said standard.

JIS B 1005 *Radii under the head for external threaded fasteners*

Remarks : The provisions cited from ISO 885 : 1976, *General purpose bolts and screws—Metric series—Radii under the head* are equivalent to the corresponding provisions in the said standard.

JIS B 1181 *Hexagon nuts and hexagon thin nuts*

Remarks : The provisions cited from ISO 4032 : 1986, *Hexagon nuts, style 1—Product grades A and B*, ISO 4033 : 1979, *Hexagon nuts, style 2—Product grades A and B*, ISO 8673 : 1988, *Hexagon nuts, style 1, with metric fine pitch thread—Product grades A and B* and ISO 8674 : 1988, *Hexagon nuts, style 2, with metric fine pitch thread—Product grades A and B*, are equivalent to the corresponding provisions in the said standard.

JIS Z 8703 *Standard atmospheric conditions for testing*

Remarks : The provisions cited from ISO 554 : 1976, *Standard atmospheres for conditioning and/or testing—Specifications* are equivalent to the corresponding provisions in the said standard.

3 Symbols and their designations The symbols and their designations in this Standard shall be as shown in Table 1.

Table 1 Symbols and their designations

Symbol	Designation	Symbol	Designation
A_{d3}	Area at nominal minor diameter, $A_{d3} = \frac{\pi}{4} d_3^2$	p_t	Failure probability in the transition range
A_s	Stress area $A_s = \frac{\pi}{4} \left(\frac{d_2 + d_3}{2} \right)^2$ Area to be used in calculations of mean stress and stress amplitude. By agreement between the user and supplier, A_{d3} may be used.	P	Pitch of the thread
d	Nominal size of the thread of the load verification stud	$R_{m,min}$	Minimum tensile strength
d_1	Basic minor diameter of the thread	R_s	Constant stress ratio $R_s = \sigma_{min}/\sigma_{max}$
d_2	Basic pitch diameter of the thread	s	Width across flats of hexagons
d_3	Nominal minor diameter of the thread, $d_3 = d_1 - \frac{H}{6}$	$S(F_A)$	Standard deviation of the fatigue load
d_a	Diameter at the point of tangency of the fillet	$S(\sigma_A)$	Standard deviation of the fatigue strength
d_h	Clearance hole diameter	$S(\log N)$	Standard deviation of logarithm of the fatigue life
d_s	Shank diameter of the load verification stud	α, β	Coefficients of regression line for the inclined part of S/N curve
D	Nominal thread diameter of the threaded test adaptor	σ_a	Stress amplitude
F_0	Tensile load	σ_A	Stress amplitude at endurance fatigue limit
$F_{0.2}$	Tensile load at proof stress $R_{p0.2}$	σ_{ax}	Axial tensile stress
F_a	Load amplitude	σ_b	Bending stress
ΔF_{aII}	Difference of load amplitudes in the transition range	σ_m	Mean stress
F_A	Load amplitude at endurance fatigue limit	σ_{min}	Minimum stress
F_m	Mean load	σ_{max}	Maximum stress
H	Height of the fundamental triangle of the thread	σ_{Min}	Minimum stress at endurance fatigue limit
N	Number of stress cycles	σ_{Max}	Maximum stress at endurance fatigue limit
N_G	The number of stress cycles in the case where the test has discontinued without failure	σ_{AN}	Fatigue strength at N cycles
p	Failure probability	σ_{AA}	Estimated value of finite life strength at $N = 5 \times 10^4$
p_t	Failure probability in the finite life range	σ_{AB}	Estimated value of finite life strength at $N = 1 \times 10^6$
		$\sigma_{a,i}$	Stress amplitude of the i^{th} test in the finite life range
		$\sigma_{a,j}$	Stress amplitude of the j^{th} test by staircase method
		$\Delta \sigma_{al}$	Interval of stress amplitude of the test at the finite life range (inclined part of S/N curve)
		$\Delta \sigma_{all}$	Difference in levels of stress amplitude in the transition range

Remarks 1 The symbol $\hat{}$ is used in the case of estimated values. For example, the estimated value $\hat{\sigma}_{AN}$ of the fatigue strength at the number of cycles N .

2 The symbol $\bar{}$ is used in the case of σ_a or $\log N$ values which are derived from the regression line; e.g. $\bar{\sigma}_a$ or $\bar{\log N}$.

Informative reference : The standard values specified in JIS B 1051 *Mechanical properties of steel bolts and screws* are generally applied to $R_{p0.2}$ and $R_{m,min}$.

4 Principle Tests are made on threaded fasteners to determine fatigue properties such as those shown by S/N curve (the Wöhler curve).

Threaded fasteners to be tested are mounted in an axial load fatigue testing machine and subjected to fluctuating tension type loading.

Tests with constant mean stress σ_m or constant stress ratio $R_s = \sigma_{\min}/\sigma_{\max}$ may be used. Constant mean stress is used generally to determine infinite life [see case (c) in Fig. 10].

Constant stress ratio is generally for quality acceptance testing [see case (a) in Fig. 10].

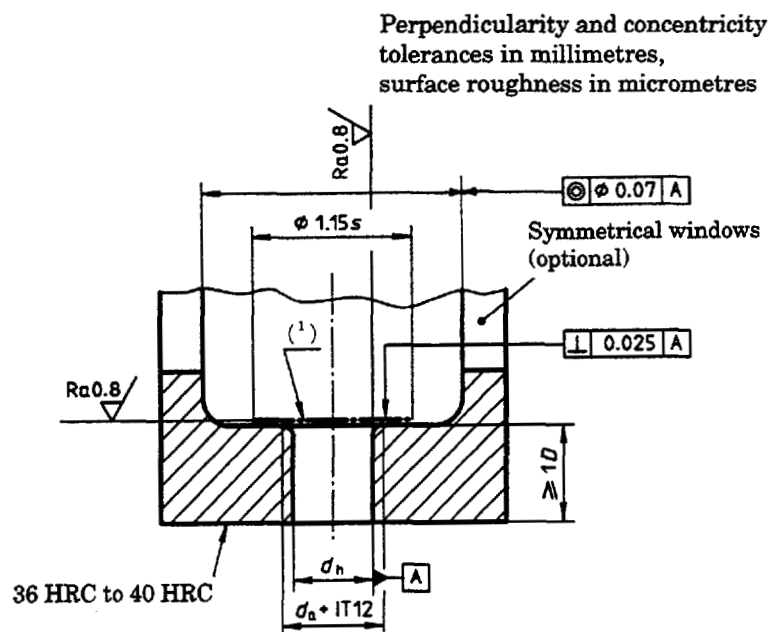
The test is continued until the test piece fails, or until a predetermined number of stress cycles has been exceeded. Generally the number of test cycles is determined by the material or by the endurance fatigue strength of the test specimen. Unless otherwise specified, the definition of failure is complete separation of the fastener into two parts.

5 Apparatus

5.1 Testing machine The testing machine shall be capable of maintaining the loads automatically to within $\pm 2\%$ of the required values throughout the test and shall be equipped with a device for counting and recording the total number of cycles per test. The testing machine shall be calibrated periodically to ensure this accuracy. The frequency range of testing shall be between 4.2 Hz and 250 Hz. The testing machine shall induce a sinusoidal fluctuation in load in the test piece.

The testing machine shall have a device to prevent its automatic restarting after stopping due to electrical power service interruption.

5.2 Test fixtures The test fixtures shall be capable of transmitting an axial load to the test piece. Figs. 1 and 2 give basic requirements. Self-aligning devices are not recommended (see 5.3).



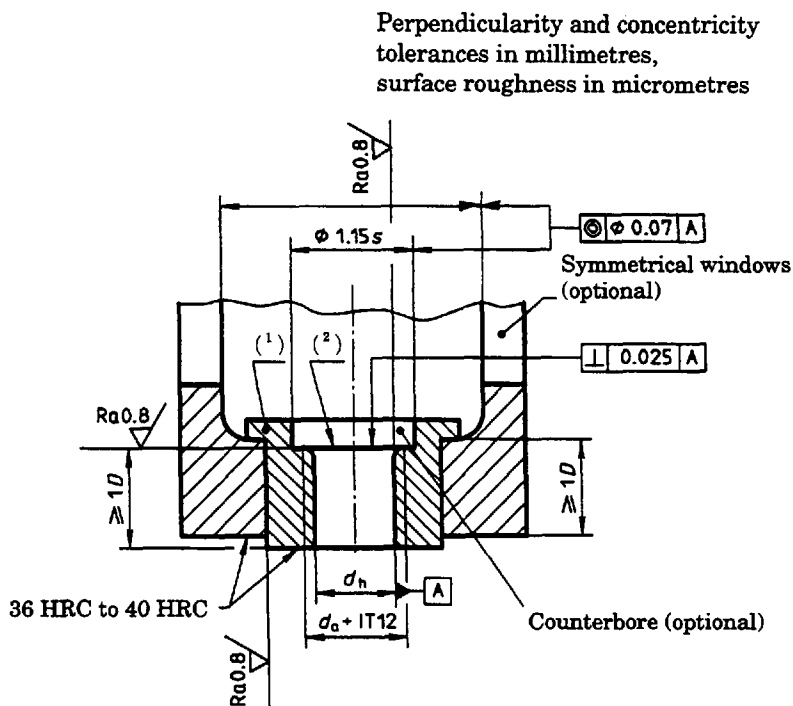
d_h is in accordance with JIS B 1001, Grade 1.

d_a is in accordance with JIS B 1005, Transition diameter (max.), column 1.

Informative reference : These are equivalent to ISO 273, *fine series* and ISO 885, *finished products*, respectively.

Note (1) Surface may be case-hardened 0.25 mm to 0.5 mm deep: maximum hardness, HRC 60; minimum hardness, 5 points HRC greater than that of the test part.

Fig. 1 Fixture (without insert)



d_b is in accordance with JIS B 1001, Grade 1.

d_s is in accordance with JIS B 1005, Transition diameter (max.), column 1.

Notes (1) The use of an insert shall not affect the rigidity of the test fixture.

(2) Surface may be case-hardened 0.25 mm to 0.5 mm deep: maximum hardness, HRC 60; minimum hardness, 5 points HRC greater than that of the test part.

Fig. 2 Fixture (with insert)

5.3 Test alignment Periodically, the alignment of the test set-up shall be verified. This shall be determined by using a load verification stud (see Fig. 3) with four strain gauges located at 90° on a common centerline around the axis. The length of the parallel part of the load verification stud shall be four times its diameter. When measured at 50 % of the load range used on the machine, the difference between the maximum stress $\sigma_{ax} + \sigma_b$ and the nominal tensile stress σ_{ax} shall not exceed 6 % of the nominal tensile stress (see Fig. 4).

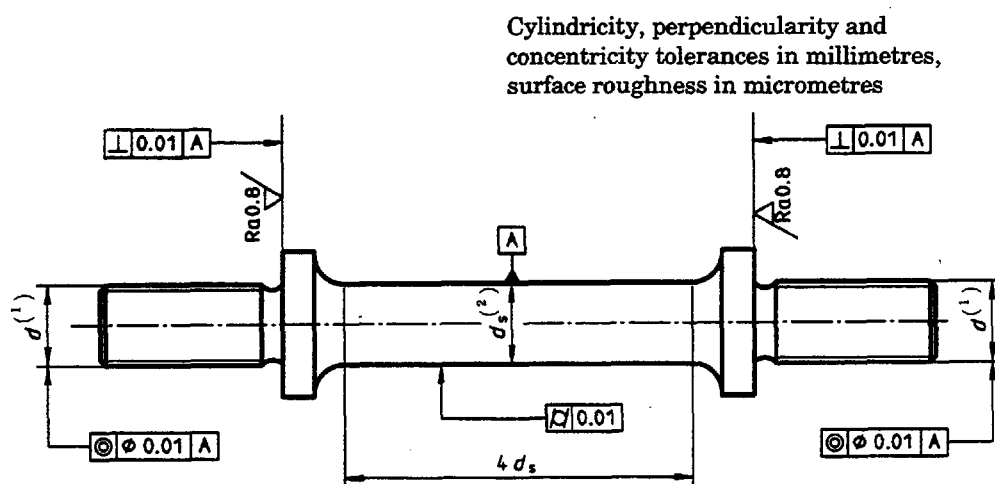
Self-aligning devices are not recommended. If they are used, alignment shall be checked carefully since any eccentric loading may cause fatigue test results to vary widely.

5.4 Internally threaded component For fatigue testing of standard products, the appropriate size and property class of nut in accordance with the text of **JIS B 1181** or a threaded adapter shall be used.

Informative reference : The text of **JIS B 1181** is equivalent to **ISO 4032, ISO 4033, ISO 8673 and ISO 8674.**

If special bolt-nut combinations are tested, a precise description of the nut shall be given as specified in 8.2.

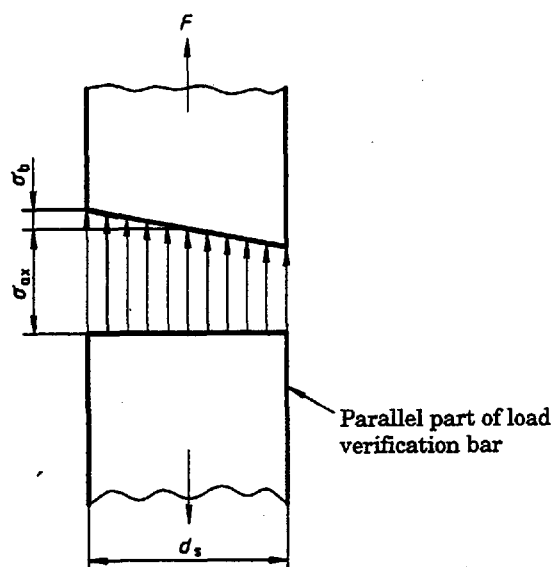
If threaded adapters according to Fig. 5 are used, they shall be described in accordance with 8.2.



Notes (1) The tolerance class of the screw thread shall be 4h.

(2) $d_s = d$

Fig. 3 Load verification stud



$$\sigma_{ax} = \frac{4F}{\pi d_s^2}$$

$$\frac{\sigma_b}{\sigma_{ax}} \leq 0.06$$

Fig. 4 Stress distribution in the shank of the load verification stud