For New Technology Network

NTN corporation

Self-Aligning Spherical Roller Bearings

LH Series

ECO series

CAT. No. 3027／E

LH Series Described

Self-aligning spherical roller bearings have found innumerable applications in industrial machinery as they are capable of carrying greater radial and axial loads on combination of these loads. The requirements for these bearings are increasingly demanding; in particular, many applications need longer life under high temperature environments.

NTN has recently developed a unique extremely durable high-temperature bearing material (STJ2) that boasts a longer service life over a wider temperature range from normal temperature to higher temperature (250˚C). Now it as a standard material for **NTN** self-aligning spherical roller bearings that need longer life under high temperature conditions.

The **NTN** LH series is a new series of self-aligning spherical roller bearings that incorporate STJ2 material to ensure Long life of High Temperature Use.

To attain high degree of durability at a higher temperature, the LH series employs either a pressed or machined cage as standard. Usually, the bearings with outside diameter of 420 mm or less are available. For details, contact **NTN** Engineering.

Technology That Helps to Realize Longer Life

The requirements for attaining longer bearing life over a wide temperature range from a normal temperature to 250˚C are:

1. Stability in alloy structure: Change in microstructure due to rolling must not occur at a higher temperature.
2. Heat resistance: Hardness must remain unchanged even at a higher temperature.

The alloy design of the STJ2 has been optimized to satisfy these requirements.

Fig. 1 illustrates variation in rolling life of the steel that has a certain amount of Si as on essential component, with the addition of varying amounts of Cr, Mo, V and Ni. From the plotting, it is apparent that Ni most positively contributes to longer rolling life.

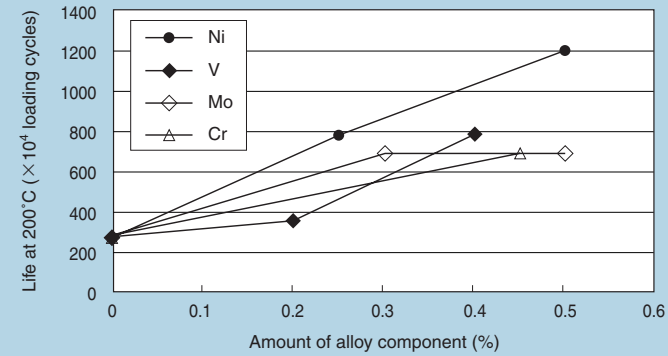
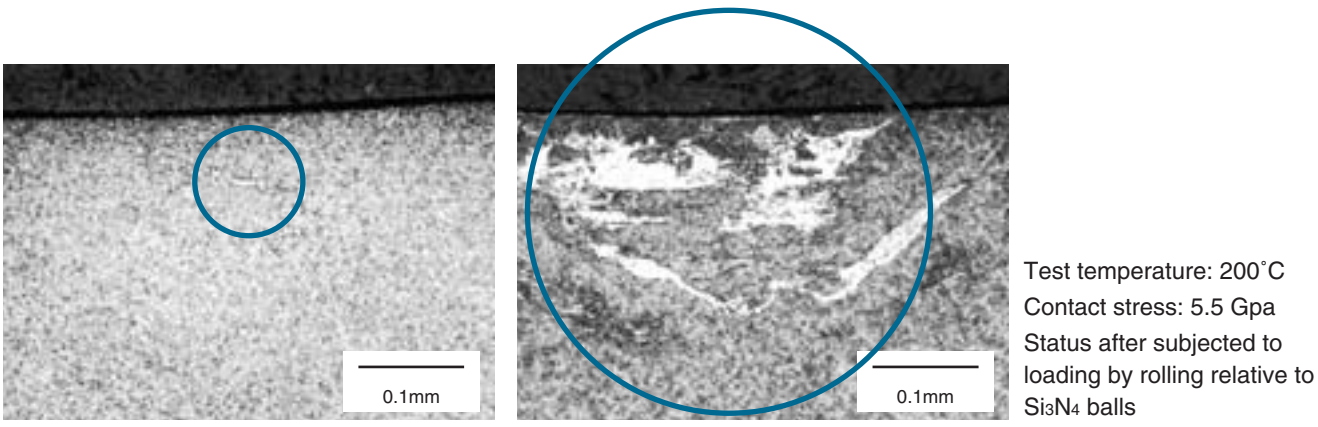


Fig. 1 Effect of alloy component on rolling life

The photos in **Fig. 2** illustrate change in microstructures that underwent high-temperature rolling test. The whitish areas in these photos represent degraded structure.

The degree of degradation is much lower with STJ2 as compared with SUJ2. This is due to the combined effect of Si and Ni.



STJ2 (No. of loading cycles: 30×10^6 cycles)

SUJ2 (No. of loading cycles: 6×10^6 cycles)

Test temperature: 200˚C
Contact stress: 5.5 Gpa
Status after subjected to loading by rolling relative to Si_3N_4 balls

Fig. 2 Comparison of changes in microstructure after high-temperature rolling test

Fig. 3 provides the data of hardness with STJ2 and SUJ2 bearing materials at a high temperature (300˚C). As can be understood from the data, STJ2 is more capable of maintaining greater hardness compared with SUJ2.

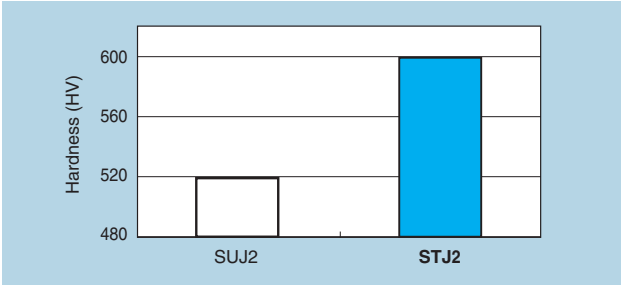


Fig. 3 Comparison of hardness at temperature 300℃

Various Strength Characteristics

1) Normal temperature life

Figs. 4 and **5** give test results under greater loading respectively with self-aligning spherical roller bearings and point contact test pieces.

Bearing tested: 22208
Test load: P/C=0.5
Running speed: 2000rpm
Lubrication: Turbine VG56 (oil bath)
Calculated life: 84h

	L_{10} (h)	Life ratio
SUJ2	122	1
STJ2	423	3.5

Test piece: ϕ12×22mm, cylindrical roller
Balls: ϕ19.05 (3/4")
Contact stress: 5.88GPa
Loading frequency: 46240 cycles/min.
Lubrication: Turbine VG56 (oil bath)

	L_{10} (×10^{7}cycles)	Life ratio
SUJ2	6.3	1
STJ2	79.8	12.7

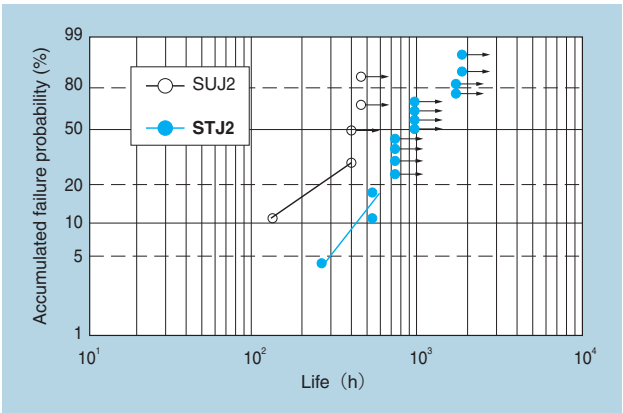


Fig. 4 Life test result with bearings

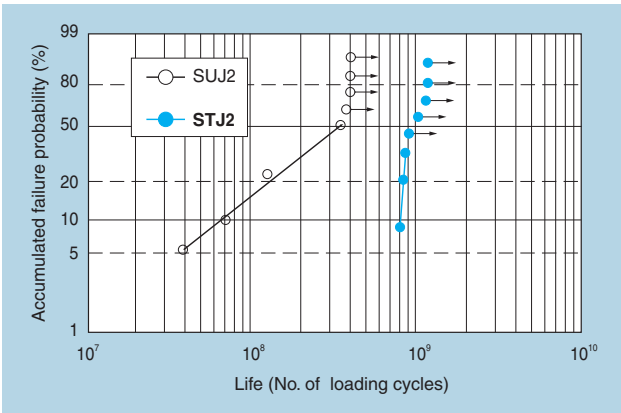


Fig. 5 Life test result with point contact test pieces

2) High-temperature life

Fig. 6 shows test result with thrust-type test pieces at 200˚C. The STJ2 test pieces can 30 times longer than the SUJ2, and still had not developed flaking.

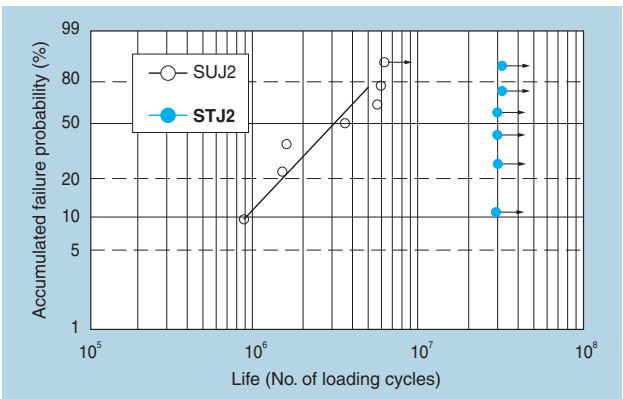


Fig. 6 High-temperature life test result with thrust-type test pieces

Test temperature: 200˚C
Test piece: ϕ47×7mm, flat plate
Balls: ϕ6.35 (1/4") Si_3N_4 balls
Contact stress: 5.5GPa
Loading frequency: 3000 cycles/min.
Lubrication: Ether-based oil

	L_{10} (×10^{5}cycles)	Life ratio
SUJ2	9.1	1
STJ2	No flaking	>30

3) Peeling resistance

Peeling will result from incomplete lubrication fluid film that leads to metal to metal contact during rolling motion. This problem tends to happen more frequently at a higher temperature range as viscosity of lubricant will decrease and lubricant can get deteriorated. **Fig. 7** offers comparison of resistance to this type of failure. Probability of peeling occurrence with STJ2 is very low-approximately 1/7 that with the SUJ2.

Contact stress: P_{max}=2.3GPa
Running speed: 2000rpm
Lubrication: Turbine VG46
Total number of revolutions: 4.8×10^5
Judging criterion: Percentage of peeled area

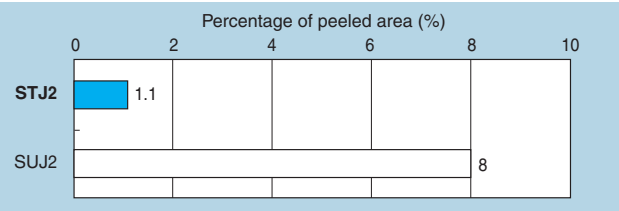


Fig. 7 Peeling resistance test result

4) Smearing resistance

Smearing is one form of seizure that results from heat build-up on the contact surface because of metal to metal contact of the contact surface that is induced by severe relative sliding. **Fig. 8** offers comparison of resistance to this type of failure. The relative velocity (sliding velocity) with STJ2 that triggers smearing is 1.4 times as high as the SUJ2.

Contact stress: P_{max}=2.1GPa
Running speed: Locating side, 200 rpm
Speed-up side, accelerated from 200 rpm
Lubrication: Turbine VG46
Judging criterion: Relative velocity at which seizure occurs

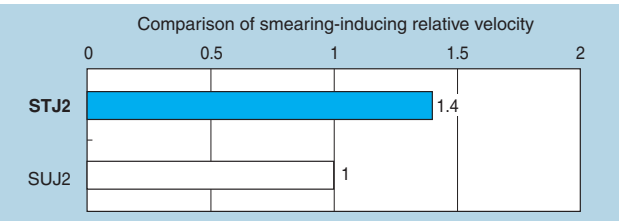


Fig. 8 Smearing resistance test result

5) Wear resistance

At a sliding contact surface such as the rib on a roller bearing, abrasive wear can occur are to metal to metal contact under poor lubricating conditions. The wear resistance with both the STJ2 and SUJ2 was evaluated using a sawin type friction and wear test machine. **Fig. 9** summarizes the test result. The wear depth with STJ2 is approximately 40% that with the SUJ2.

Contact stress: P_{max}=94MPa
Sliding velocity: 10m/s
Lubrication: Turbine VG2
Test duration: 10min
Judging criterion: Depth of wear mark

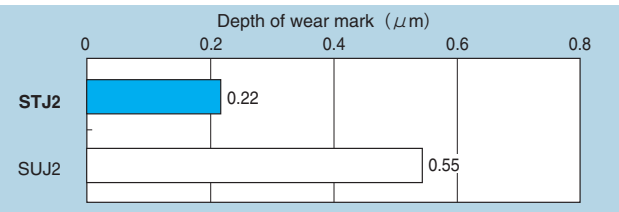


Fig. 9 Wear resistance test result

6) High-temperature dimensional stability

Fig. 10 graphically plots dimensional change with test pieces that were maintained at 250˚C. The dimensions of STJ2 test piece remained virtually unchanged after 2500 hours-performance equivalent to heat-treated SUJ2.

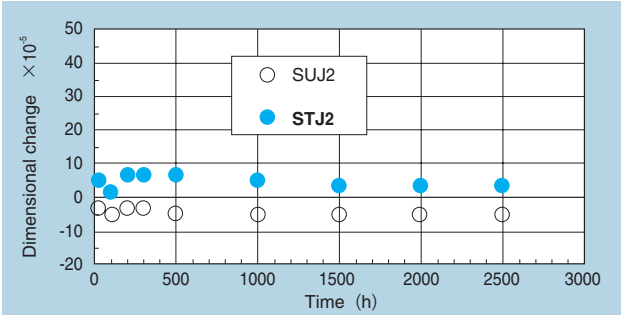


Fig. 10 Dimensional change at high temperature

7) Rolling fatigue-crack resistance

Rolling fatigue tests were performed both at normal temperature and with greater fit stress at higher temperature. **Figs. 11** and **12** summarize the test results with normal temperature and higher temperature, respectively. Under both temperature conditions, STJ2 exhibited fatigue resistance twice as great as that with the SUJ2.

Test piece: Ring-type test piece
Test temperature: Normal temperature
Fit stress: 425MPa
Contact stress: P_{max}=3GPa
Lubrication: Turbine VG68

	L_{10}(×10^7cycles)	Life ratio
SUJ2	1.7	1
STJ2	3.5	2

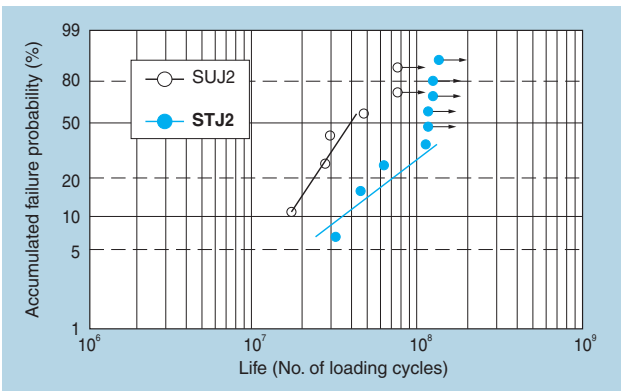


Fig. 11 Fatigue-crack life at normal temperature

Bearings tested: 62/32
Test temperature:
SUJ2 : 150˚C
STJ2 : 200˚C
Fit stress: 350MPa
Contact stress: P_{max}=3.2GPa
Lubrication: Ether-based oil

	L_{10} (h)	Life ratio
SUJ2	272	1
STJ2	515	2

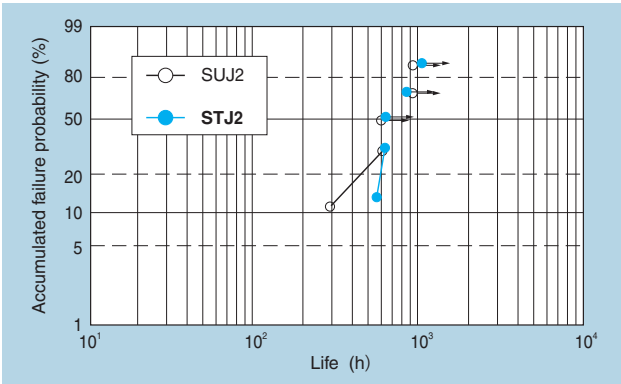


Fig. 12 Fatigue-crack life at high temperature

NTN Self-Aligning Spherical Roller Bearing LH Series

A unique high-temperature enduring material which is positively compatible with the global environment, has been adapted to the **NTN** self-aligning spherical roller bearing series.

Characteristics of New Material

1) Extended service life in normal to higher temperature ranges
Service life at a normal temperature range is 3.5 times as long as the previous SUJ2.
Service life at a higher temperature (200˚C) is 30 times as long as the previous SUJ2.

2) Roller's raceway surface positively resists possible surface damages
Seven times as resistant against flaking as the SUJ2 (one seventh possible occurrence of flaking).
1.4 times as resistant against smearing as the SUJ2 (smearing-inducing relative velocity is 1.4 times that of SUJ2).
2.5 times as resistant against wear as the SUJ2 (wear depth is 1/2.5 that of the SUJ2).

3) Good dimensional stability at higher temperature
Virtually no change in dimensions at 250˚C.

4) Enhanced fatigue-crack resistance
Fatigue-crack life under higher temperature and greater fit stress is twice as long as the SUJ2.
Resistance to rolling fatigue-crack is twice as great as the SUJ2.

5) One design, multitype applications, less inventory
One standard type alone can cope with normal to higher temperature (250˚C) applications.