MOTION & CONTROL
NSK

SWR™ Bearing

Greater wear resistance achieved by NSK's innovative material and heat treatment technologies.
Excellent bearing life properties and high core toughness of the SWR bearing steel enhance overall durability.
Best suited to meet the needs of customers using spherical roller bearings for continuous casting guide rolls.

New!

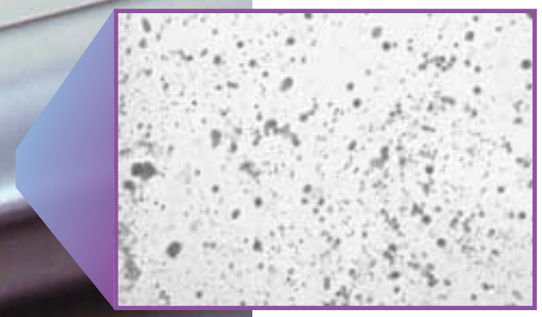
SWR bearings use newly improved bearing steel developed by NSK that offers improved wear resistance and flaking life. The SWR Bearing—Stiff, Tough & Reliable

NSK has explored ways to extend bearing life by focusing research efforts on bearing material and heat treatment technologies. The result is a newly developed SWR™ (super wear-resistant) bearing steel that addresses the needs of customers faced with meeting the challenges of operating bearings in the harsh environment of continuous casting machines.

NSK succeeded in using carbonitriding technology for attaining precipitation of hard and fine-grained carbonitrides. This is the first time in the world that carbides technology has been combined with a special alloy to develop a new bearing steel for rolling bearing applications. Carbonitrides in SWR bearing steel (upper far-right) is very fine-grained in comparison to carbonitrides found in conventional material, such as AISI 52100 steel (lower far-right). Excellent wear resistance is achieved by ensuring the steel contains large amounts of precipitation of hard and fine-grained carbonitrides.

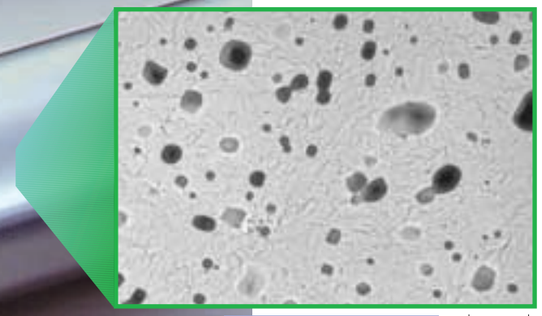
The excellent wear resistance, combined with the application of NSK TF technology, ensures superior flaking life of SWR bearings operating under contaminated lubrication conditions.

Furthermore, surface-hardening of SWR bearing steel dramatically increases core toughness, and is considerably more resistant to fracturing compared with through hardened AISI 52100 steel.



SWR bearing steel

1 μm



Conventional bearing steel

1 μm

Material photos are the results extraction replica work using transmission electron microscopy (TEM).

TF technology includes a unique heat treatment process developed by NSK to optimize the level of retained austenite in bearing material, which minimizes the stress concentration around surface defects, thus achieving extended flaking life performance under contaminated lubrication conditions.

NSK was the first in the world to conduct research on material with small stress concentrations. Our research revealed that by changing the amount of retained austenite, we could reduce the number of stress concentrations at the edges of indentations.

(Japanese patent No. 2128328, U.S. patent No. USP4904094, and German patent No. DE3922720C2)

SWR™ Bearing

1. Wear Resistance

Figure 1 shows the results of a two-ring wear test for evaluating the wear resistance of SWR bearings at ultra-low speed. These results illustrate the excellent wear resistance of NSK's newly developed SWR bearing steel, which offers approximately seven times more wear resistance than that of conventional AISI 52100 steel.

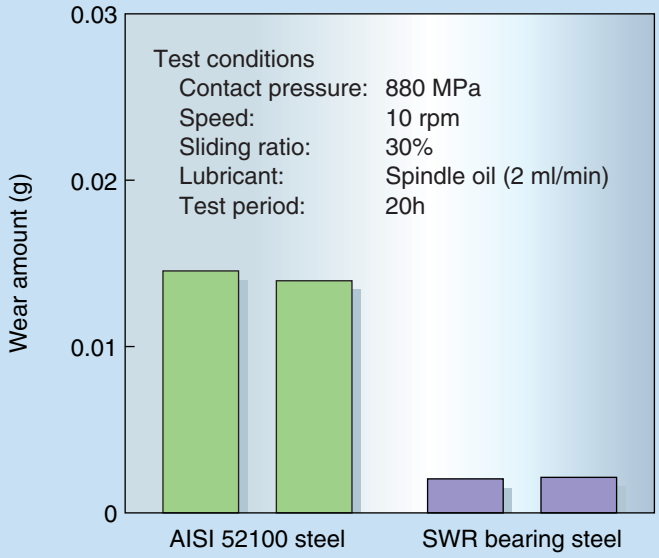
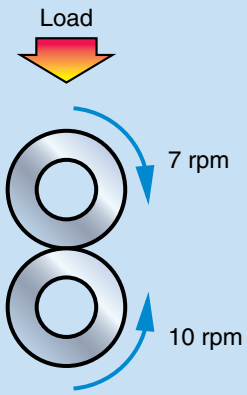


Fig. 1 Results of two-ring wear test

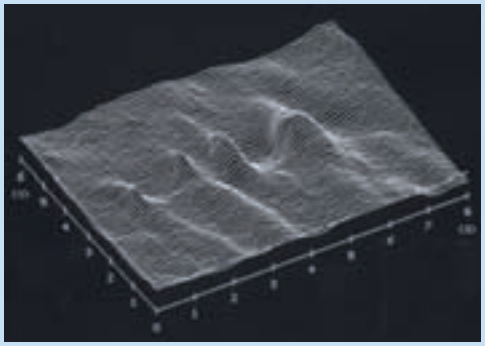


Schematic of two-ring type wear test

Oil lubrication
7 Times Greater Wear Resistance

Photos 1 and 2 show SEM micrographs of two worn surfaces as observed by a scanning electron microscope (SEM), below them are 3D images of the same wear surfaces. Precipitation remained on the wear surface of the SWR bearing steel as shown rising from the surface. However, the whole surface of the AISI 52100 steel was worn. These observations demonstrate that SWR bearing steel is superior in wear resistance due to the high hardness of the carbonitrides.

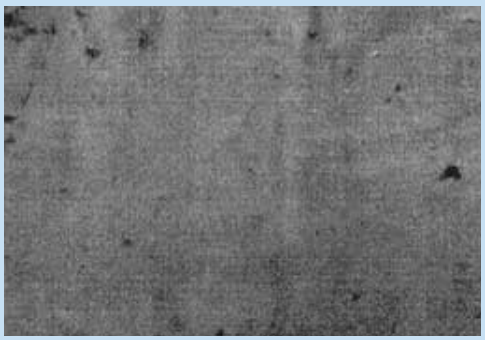
Photo 1 SWR bearing steel

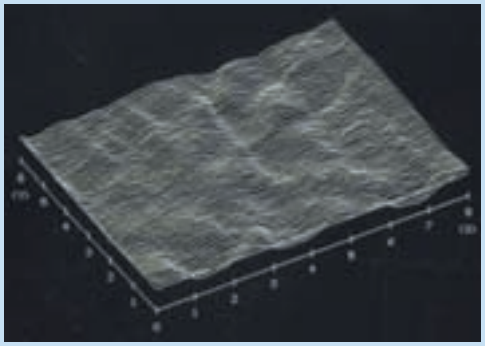


SWR bearing steel

VS

Photo 1 AISI 52100 steel





Conventional AISI 52100 steel

2. Surface Originated Flaking Life

Figure 2 shows evaluation results of surface originated flaking characteristics under contaminated lubrication conditions using a thrust type life tester. Application of NSK's original TF technology in development of the SWR bearing steel ensures long life as demonstrated in the test results. NSK has succeeded in optimizing the amounts of retained austenite for lowering stress concentrations, and has achieved high hardness by precipitation of a significant amount of fine carbonitrides. Based on L10 life where cumulative failure probability is 10 percent, our SWR bearing steel life is five times longer than that of conventional AISI 52100 steel.

Fig. 2 Results of thrust type life test under contaminated lubrication

5 Times Longer Life

3. Core Toughness

Surface hardening of the SWR bearing steel offers core toughness that is superior to that of conventional AISI 52100 steel. Results of the core toughness test show that fracture toughness of the SWR bearing steel is five times higher than that of conventional material making it more resistance to crack development and fracturing.

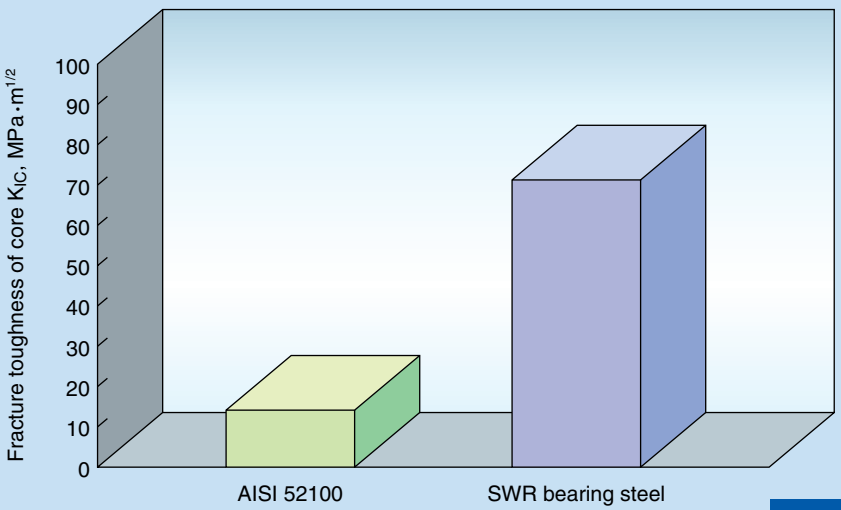


Fig. 3 Results of fracture toughness test

5 Times Higher Core Hardness

4. Failure Mechanism of Guide Roll Bearings of a Continuous Casting Machine

Spherical roller bearings for guide rolls operate under extremely severe conditions and suffer from wear that would not normally occur under most other operating conditions. In the worst cases, bearings may even fracture. NSK conducted extensive research to find a solution to this problem.

We came to a clearer understanding of the following process, which leads to bearing failure:

1) The bearing is operated at an extremely low speed and suffers from insufficient lubrication due to the difficulty of drawing lubricant over the contact surface areas of the rolling elements and the inner and outer rings. Matters are further complicated by the entry of water and fine dust into the bearing interior. Additional wear occurs on the raceway surface due to differential slip and spin slip of the spherical rollers.

2) Stress concentrates at the pure rolling points with little wear, and flaking develop under the concentration of stress.

3) Finally bending stresses acting on the outer ring promote further cracking along the fracture.

NSK examined measures that can be taken against wear, flaking, and fracturing. We focused on improvements to material and heat treatment for obtaining long life with the same type of bearing as conventional bearings that require no modifications to equipment.

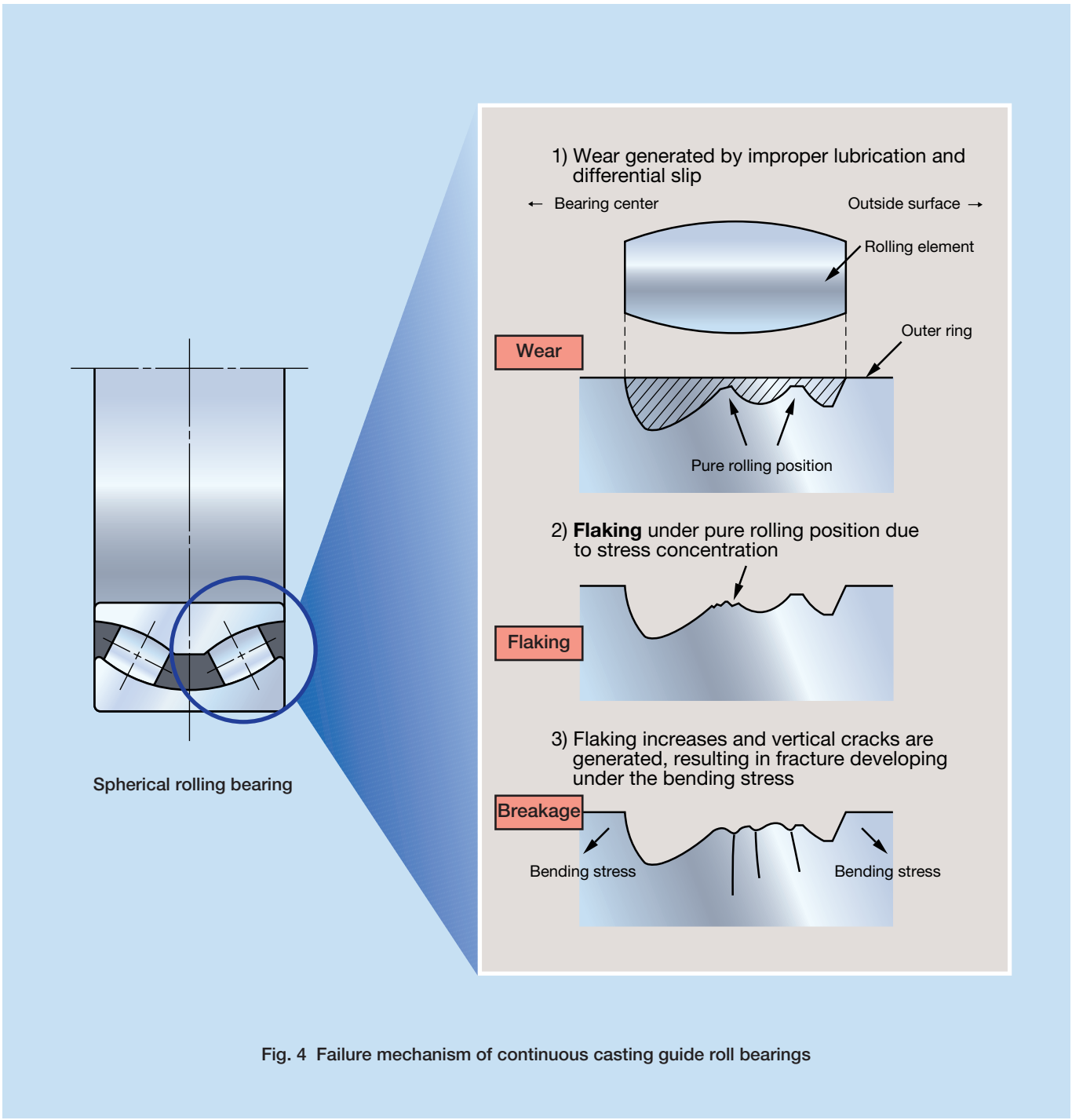


Fig. 4 Failure mechanism of continuous casting guide roll bearings

5. Results of Simulation Testing with a Continuous Casting Machine

Figure 5 illustrates the durability testing results of two 22210CD spherical roller bearings operated at ultra-low speed under water-infiltrated lubrication to simulate the environment of a continuous casting machine. Cross-section profiles of the outer ring raceway of both bearings after testing at the maximum loaded regions are also shown in Figure 5. The hatched areas indicate wear.
In comparing the maximum wear depth of both bearings, wear of the SWR bearing was only one-third that of the conventional bearing. This means that wear resistance of the SWR bearing is three times that of conventional bearings. In further comparison of the wear amount as indicated in the hatched areas of Figure 5, the amount of wear in the SWR bearing was merely one-seventh that of the conventional bearing. This shows that wear resistance of SWR bearing is seven times that of conventional bearings. Water content in grease collected from the bearing interior after testing was at about 2 % for the conventional bearing and 12 % for SWR bearing. Although lubricating conditions were very severe for the SWR bearing, wear resistance remained excellent.
In addition to excellent wear resistance, SWR bearing steel has excellent surface originated flaking life due in part to the material and heat treatment technologies of NSK. By improving core toughness, we also enhanced the resistance to fracturing that is generated by the development of flaking cracks.
Please consult with NSK regarding the selection of bearings.

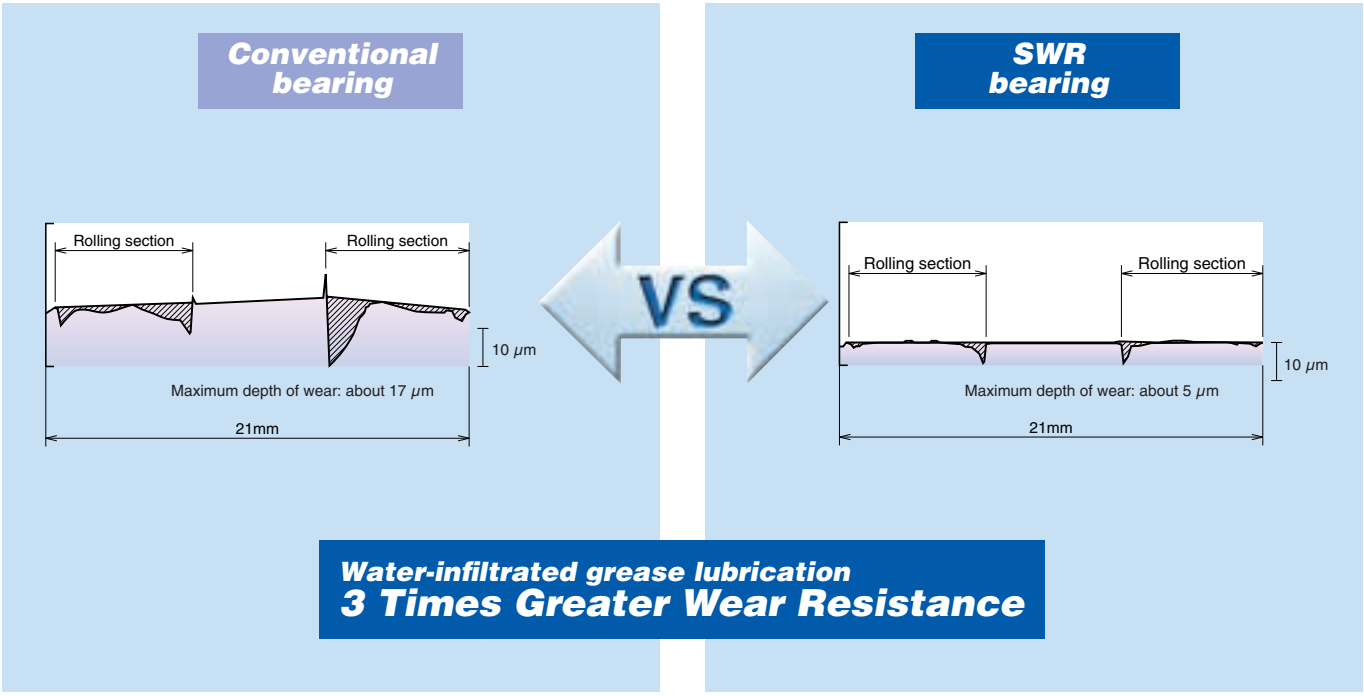


Fig. 5 Cross-section profile of the outer ring raceway after test (maximum loaded region)
Test conditions: Load: 25 kN; Speed: 4 rpm; Test time: 336 h