For New Technology Network

NTN®

World-Class Long Life

FA Tapered Roller Bearing

《Patent Pending》

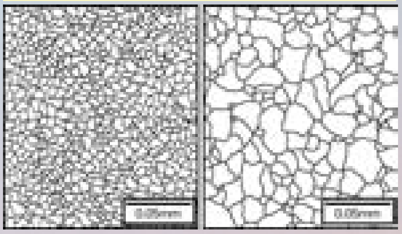
FA Treatment

Fine Austenite Strengthening

Drastically improved fatigue strength

Special heat treatment (FA treatment) with crystal grains of bearing steels reduced by half to those of conventional grain size

Pattern Diagram of Prior Austenite Grain Boundaries



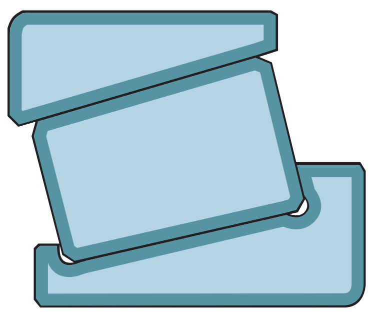
FA treated Standard

CAT. No. 3802/E

From carburized steel to bearing steel
World-Class Extended Life Bearing Steel

NTN “FA Tapered Roller Bearing”

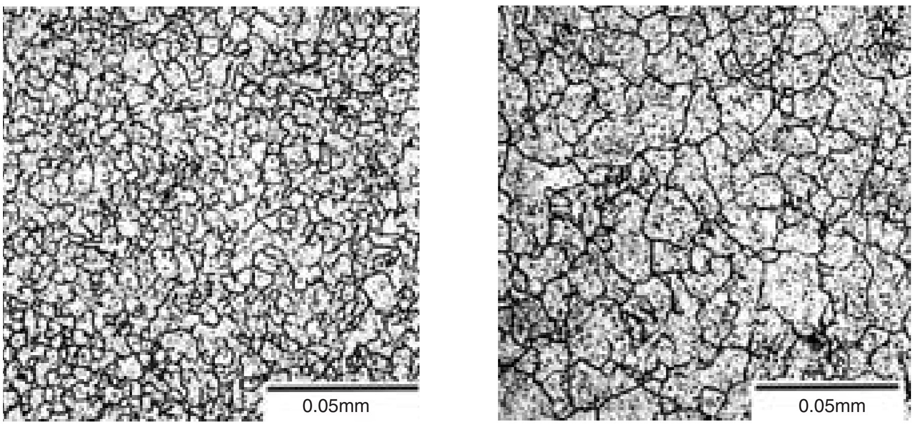
The "FA Tapered Roller Bearing" series is the successor to conventional small tapered roller bearings. It is an amalgam of the world's first specialized heat treatment (i.e. FA treatment) and the technology developed through experience with optimizing internal bearing design.



The entire material has uniform refined prior austenite grain structure, and the surface layer ( ) is carbonitrided for reinforcement.

FA treatment (Fine Austenite Strengthening)

- Extended life obtained through the specialized grain refinement processing of bearing steel
- FA-treated bearing steel exhibiting an average grain size approx. half that of conventional material grain size.



FA treated Standard

Prior-austenite grain microstructures

1 FA-Treated Bearing Performance (Compared to 4 Top NTN Tapered Roller Bearings)

1) Average bearing life was 3 times longer (under clean lubricant conditions).

2) Average bearing life was 14 times longer (under contaminated lubricant conditions).

3) Torque reduction greater than 10% within the practical speed range.

4) 25% improvement in seizure resistance with normal rotating speed and double the contact stress.

5) 50% reduction in loss of preload.

6) 50% reduction in the number of revolutions to achieve bearing stand height stabilization.

7) Improved indentation resistance (approximately 1.5 times).

2 What is an FA-Treated Tapered Roller Bearing?

NTN has most recently focused its attention on the processing technology that can improve the fatigue strength of bearing steel through grain refinement. Specifically, it has developed a specialized heat treatment process (i.e. FA treatment) that refines the prior austenite grain size of bearing steel by more than half that of conventionally used material. The "FA Tapered Roller Bearing" is a direct result of this technological development; offering improved indentation resistance and providing greatly extended bearing life even under contaminated lubrication conditions. Furthermore, by combining this "FA treatment" with the design work that was originally developed for ECO-Top tapered roller bearings (to optimize the internal design) the seizure resistance on the rib flange has been improved. The combination of these improvements results in a significant reduction of the required bearing size.

Note) FA treatment: Abbreviation of "Fine Austenite Strengthening" treatment

(1) Extended Life

- **Enhanced rolling contact fatigue life through grain refinement.**
- **Optimized amounts of retained austenite via. carbonitriding and improved resistance to surface-originating damage (due to contaminants) through grain refinement.**
- **Specialized crowning designed to provide optimal contact stress distribution under varying load conditions.**

It is known that the bearing life ratio varies with the condition of the lubricant. However, even under contaminated conditions the FA-treated bearings lasted 14 times longer than the 4 Top tapered roller bearings and approximately 3 times longer when using clean lubricant.

(2) Optimal Design for Oil Film Formation

It is generally known, that 1) The rib of a tapered roller bearing slides when it comes in contact with the rolling elements and that 2) The ability of the rib to maintain an oil film of sufficient thickness greatly affects the performance and life of the bearing.

FA tapered roller bearings, exhibit a reduction in rotational torque, seizure resistance, and loss of preload by employing design technology that was originally developed for ECO-Top tapered roller bearings (to optimize the shape, roughness, and precision of the contact between the rib and roller components).

(3) Reduction in Bearing Stand Height Stabilization

When assembling tapered roller bearings under preload, it is necessary to rotate them sufficiently until the roller ends stabilize or properly seat against the surface of the rib flange. Thus, the fewer number of revolutions required before stabilization, the faster the preload can be adjusted, speeding up the assembly process.

Given the optimized internal design of the FA tapered roller bearings, the preload setting can be adjusted precisely within a shorter period of time. In fact, to reduce time, these units can be assembled and stabilized right out of the packaging (with the existing rust preventative oil) without the need for any additional gear oil.

(4) Improved Indentation Resistance

Commonly, when reducing bearing size, indentation resistance needs to be improved to prevent a reduction in the safety ratio (due to a drop in the load rating).
With FA tapered roller bearings, the indentation depth is less than one ten thousandth of the roller diameter and does not hinder smooth rotation of the bearing (even if the unit is exposed to a static load safety ratio (S_0) = 0.6).

3 Test Data

(1) Life

Table 1 Results of life test with clean oil
(Comparison test results using line contact type specimen)

	L_{10} life, ×(10^4 cycle)	L_{10} life ratio
4Top	1,523	1.0
ECO-Top (ETA)	3,140	2.1
FA	**4,290**	**2.8**

* The L_{10} life ratio is given with the life of 4Top as 1.0.

(Line contact type life test conditions)

Test rig : **NTN** line contact type life test rig
Specimen : ϕ 12×L12, R480
Counter specimen : ϕ 20 roller
[SUJ2 (SAE52100 EQUIVALENT)]
Load (kN) : 13.74
Contact stress (MPa) : 4155 (P_{max})
Lubricating oil : Turbine oil 68

Table 2 Results of life test with contaminated oil
(Comparison test results using bearings)

Test condition		4Top	ECO-Top (ETA)	**FA**
Condition ①	L_{10} life (h)	52.4	314.9	**415.6**
	L_{10} life ratio	1.0	6.0	**7.9**
Condition ②	L_{10} life (h)	22.5	—	**309.7**
	L_{10} life ratio	1.0	—	**13.8**

* The L_{10} life ratio is given with the life of 4Top as 1.0.

(Bearing life test conditions)

Test rig : Bearing life test rig type Ⅵ
Test bearing : ① 30206
: ② 30306D
Test load : ① F_r=17.64kN, F_a=1.47kN
② F_r=19.6kN, F_a=13.72kN
Rotating speed : 2000min^{-1}
Lubricating oil : ① Turbine oil 56, oil bath (30ml)
② ATF oil bath (50ml)
Contaminants : ① 50 μm or smaller : 90wt %, 100 to 180 μm : 10wt % } 1.0g/l
② 50 μm or smaller : 75wt %, 100～180 μm : 25wt % } 0.2g/l
Calculated life : ① 169h (no contaminants)
② 171h (no contaminants)

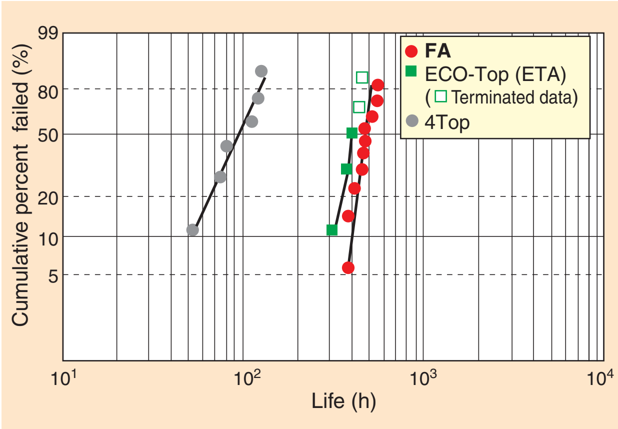


Fig. 1 Condition ① Results of life test for 30206
(With contaminated lubricant)

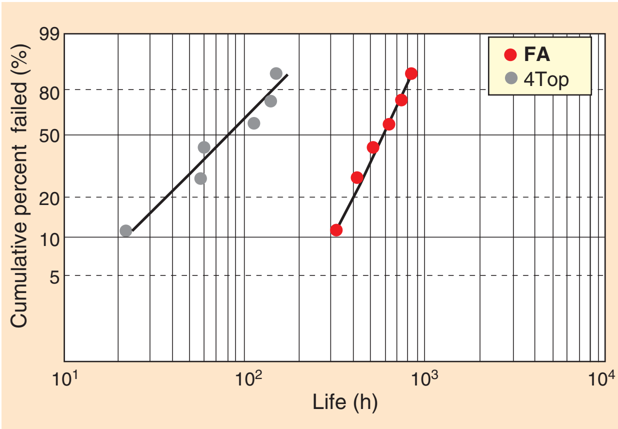


Fig. 2 Condition ② Results of life test for 30306D
(With contaminated lubricant)

(2) Rotational torque

【Test Conditions】
Bearing: : 30206
Axial load : 4kN
Lubricating oil : Gear oil 70W90 (GL-4)

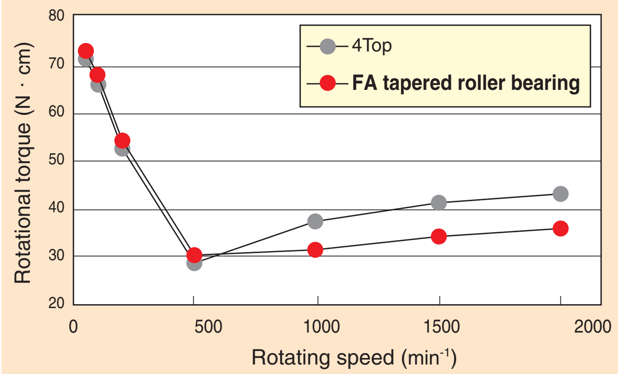


Fig. 3 Rotational torque measurement results

(3) Seizure resistance

【Test Conditions】
Bearing：30206
Lubricating oil：Turbine oil 56
Oil temperature：40±3˚C
Load：P_r/C_r=0.45
Oil volume：40ml/min

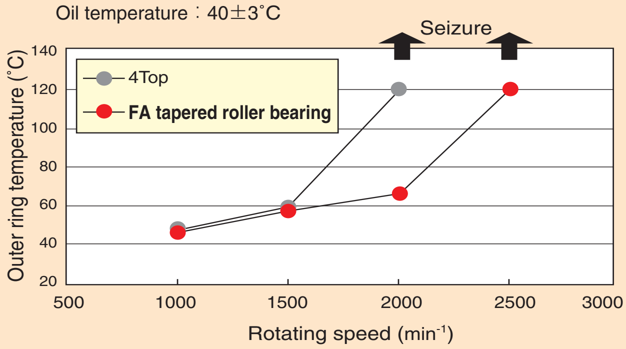


Fig. 4 Seizure resistance test results

【Test Conditions】
Bearing：30306D
Lubricating oil：Turbine oil 56
Oil temperature：40±3˚C
Load：F_a=3.4～13.7kN
Oil volume：40ml/min

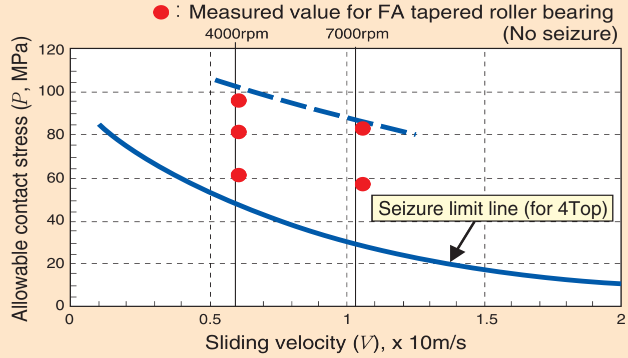


Fig. 5 Contact stress resistance test results

(4) Preload loss vs time

【Test Conditions】
Bearing：30206
Preload：4900N
Oil volume：60ml/min
Rotating speed：3000min^{-1}
Lubricating oil：Turbine oil 56
Oil temperature：40±3˚C

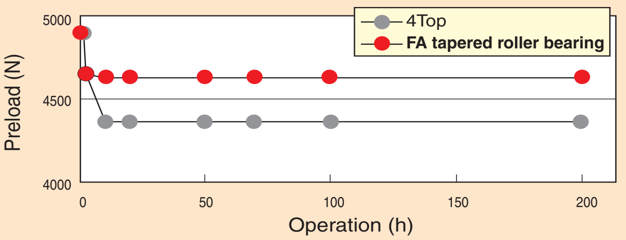


Fig. 6 Preload loss vs time test results

(5) Early stabilization of bearing stand height

Test Method: With the bearing positioned as shown in Fig. 7, an axial load (weight A) is applied to rotate the inner ring, and the bearing stand height is measured for each revolution. The number of revolutions required for the bearing to stabilize is determined.

Bearing : 30206
Axial load : 29.4N

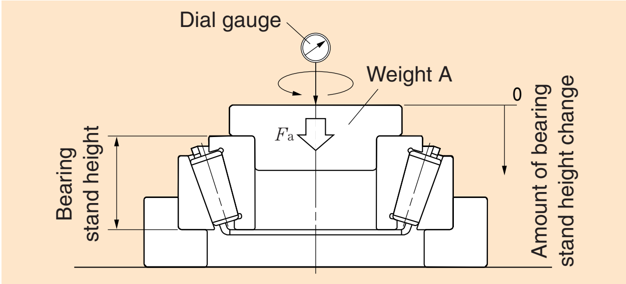


Fig. 7 Stand height stabilization test method

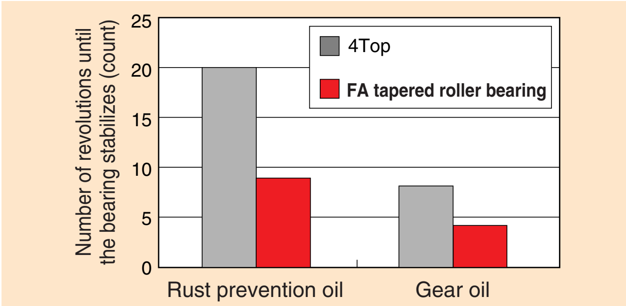
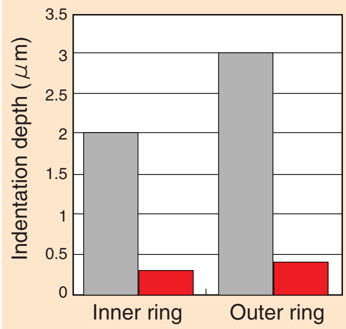


Fig. 8 Results of measuring number of revolutions until the bearing stabilizes

(6) Indentation resistance

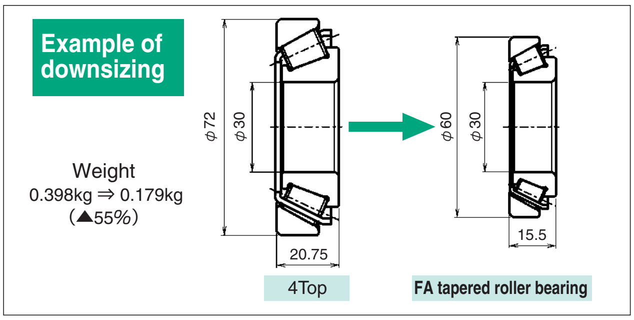


【Test Conditions】
Bearing: 30306D
Load: F_a=215kN
Rated capacity ratio: 1.67 C_0
Safety factor: S_0=0.6
Roller diameter: 9.18mm

Fig. 9 Indentation depth measurement results

4 Size Reduction by Employing FA Tapered Roller Bearings

As a result of improvement in bearing life, seizure resistance and indentation resistance, employment of FA tapered roller bearings will reduce the bearing size.



5 Applicable Bearing Size

FA tapered roller bearings with outer diameter 145 or smaller are available. For details, please contact **NTN**.