



KOYO LONG LIFE BEARINGS

KE Bearing & SH Bearing

Performance of Long Life Bearings (Compared with Conventional Bearings)

	KE Bearing	SH Bearing
● Life in Contaminated Oil	10 times or longer	10 times or longer
● Dent Resistance	10 times or more	8 times or more
● Wear Resistance	2 times or more	1.5 times or more
● Life in Clean Oil	2 times or longer	6 times or longer

KE Bearing – Case Hardened Steel

SH Bearing – Through Hardened Steel

Flaking Mechanism and Countermeasures

Modes	FLAKING IN CONTAMINATED OIL			FLAKING IN CLEAN OIL
	FLAKING INITIATED FROM SURFACE			FLAKING INITIATED FROM SUB - SURFACE
	PEELING	MIXED FLAKING	FLAKING FROM DENT	
Appearance				
Mechanism	 Abrasive wear by small and hard particles	 Abrasive wear by small hard particles, and plastic deformation by large hard particles	 Plastic deformation caused by outside force or large and hard particles	 Material defect at maximum shear stress
Measures	<p>Harder Surface Hardness for</p> <ul style="list-style-type: none"> • Improve Wear Resistance • Reduce Plastic Deformation <p>↓</p> <p>KE Bearing ← Optimized Retained Austenite</p> <ul style="list-style-type: none"> • Early Disappearance of Plastic Deformation <p>Forming of Carbonitride</p> <p>→ SH Bearing</p>			<p>Optimized matrix C %</p> <p>Optimized surface hardness of rolling element</p> <p>Stabilized structure for high temperature</p> <p>Formed high residual compressive stress on surface</p>

FLAKING IN CONTAMINATED OIL & COUNTERMEASURES

1. Flaking from Dent & How to get Long Life

Flaking Process																												
Analyzed Data	<p>Harder raceway surface proved smaller initial risen height</p> <table border="1"> <caption>Initial risen height vs Raceway surface hardness</caption> <thead> <tr> <th>Raceway surface hardness (HRC)</th> <th>Initial risen height h_0 (μm)</th> </tr> </thead> <tbody> <tr><td>60</td><td>3.5</td></tr> <tr><td>61</td><td>3.0</td></tr> <tr><td>62</td><td>2.5</td></tr> <tr><td>63</td><td>2.0</td></tr> <tr><td>64</td><td>1.5</td></tr> </tbody> </table>		Raceway surface hardness (HRC)	Initial risen height h_0 (μm)	60	3.5	61	3.0	62	2.5	63	2.0	64	1.5	<p>Risen height became smaller by repeated running</p> <table border="1"> <thead> <tr> <th>γR</th> <th>Surface Hardness</th> <th>A</th> <th>B</th> </tr> </thead> <tbody> <tr> <td>16.9%</td> <td>62.2 HRC</td> <td>○</td> <td>●</td> </tr> <tr> <td>31.5%</td> <td>62.9 HRC</td> <td>□</td> <td>■</td> </tr> </tbody> </table>		γR	Surface Hardness	A	B	16.9%	62.2 HRC	○	●	31.5%	62.9 HRC	□	■
Raceway surface hardness (HRC)	Initial risen height h_0 (μm)																											
60	3.5																											
61	3.0																											
62	2.5																											
63	2.0																											
64	1.5																											
γR	Surface Hardness	A	B																									
16.9%	62.2 HRC	○	●																									
31.5%	62.9 HRC	□	■																									
Counter-measures	<p>By harder surface hardness or forming carb-nitride stratum, initial risen height h_0 caused by particles can be reduced.</p> $h_0 \text{ conventional bearing} > h_0 \text{ KE bearing} \geq h_0 \text{ SH bearing}$		<p>By optimizing retained austenite (γR) risen height (h) can be disappeared in early stage.</p> $h \text{ conventional bearing} > h \text{ SH bearing} \geq h \text{ KE bearing}$																									

--	--	--	--

<p>By optimizing retained austenite (γR), work hardening of risen area could be repressed</p> <p>Conventional bearing Risen area had work hardening and not disappeared easily</p> <p>Long life bearing Risen area showed small work hardening and easily disappeared</p>	<p>Smaller risen height showed smaller shear stress</p> <p>• A detail</p> <p>Small ← Risen height → Large</p>	<p>Smaller risen height showed longer life</p>
--	---	--

<p>Risen height (h)</p> $h \text{ conventional bearing} > h \text{ SH bearing} \geq h \text{ KE bearing}$ <p>Therefore, shear stress (τ)</p> $\tau \text{ conventional bearing} \gg \tau \text{ SH bearing} \geq \tau \text{ KE bearing}$	<p>By increasing surface hardness and optimizing retained austenite.</p> $\text{Life}_{\text{conventional bearing}} < \text{Life}_{\text{SH bearing}} \leq \text{Life}_{\text{KE bearing}}$
--	---

2. Peeling & How to get Long Life

<p>Peeling Process</p>	<p>①</p>	<p>②</p>	<p>③</p>	<p>④ Peeling</p>
<p>Analyzed Data</p>	<p>Harder raceway surface proved longer life</p> <p>Life L(h)</p> <p>Surface hardness (HRC)</p> <p>Hardness of test particles</p>		<p>Retained austenite (γ_R) not related with peeling</p> <p>Life L(h)</p> <p>γ_R (%)</p> <p>Weibull slope</p> <p>Weibull slope</p> <p>γ_R (%)</p>	
<p>Counter-measures</p>	<p>By increasing raceway surface hardness than particle hardness or forming carbonitride stratum, wear resistance can be improved.</p> <p>Life conventional bearing < Life SH bearing \leq Life KE bearing</p>			

BEARING LIFE EVALUATION RESULTS AGAINST FLAKING (Compared with Conventional Bearings)

Life in contaminated oil
KE bearing, SH bearing
:10 times or longer

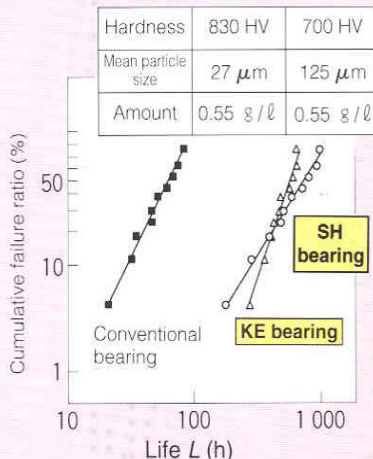


Fig. 1 Life test result in contaminated oil

Life in clean oil

KE bearing : 2 times or longer
SH bearing : 6 times or longer

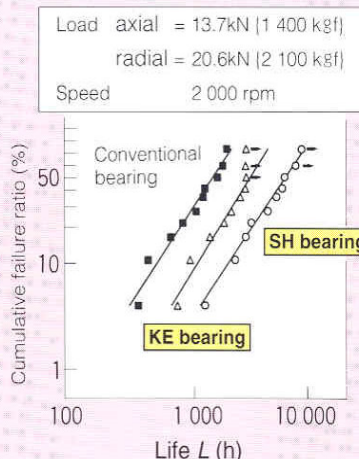


Fig. 2 Life test result in clean oil

Dent resistance

KE bearing : 10 times or more
SH bearing : 8 times or more

Dent area ratio measured at 20 points of inner ring raceway center and analyzed by computer

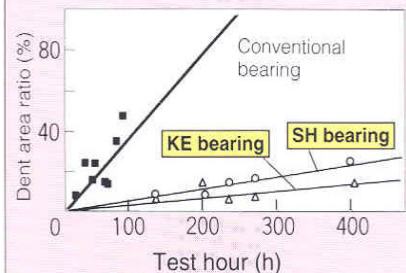
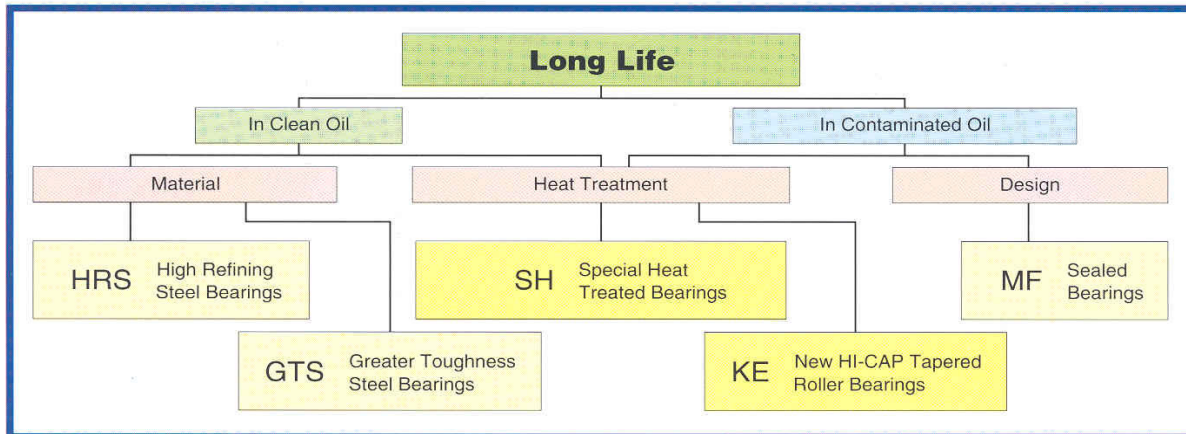
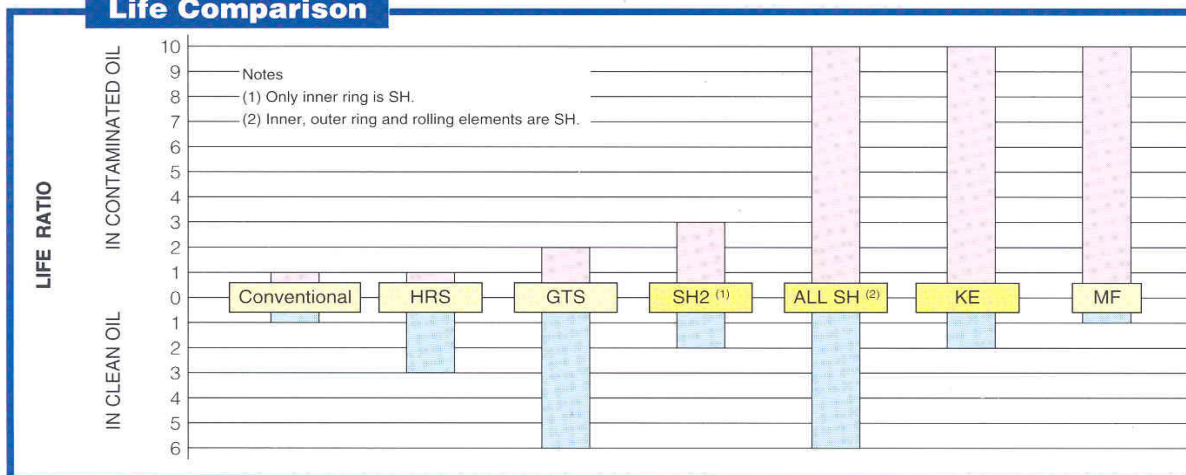


Fig. 3 Test hour vs dent area ratio in contaminated oil

■ KOYO Long Life Bearings



Life Comparison



INTERNATIONAL NETWORK

KOYO SEIKO CO., LTD. HEAD OFFICE
 TEL: 81-6-6245-6087 FAX: 81-6-6244-0814

KOYO CANADA INC.
 TEL: 1-905-681-1121 FAX: 1-905-681-1392

* **KOYO CORPORATION OF U.S.A.**
 TEL: 1-440-835-1000 FAX: 1-440-835-9347

* **KOYO CORPORATION OF U.S.A. (AUTO SALES & TECHNICAL CENTER)**
 TEL: 1-734-454-1500 FAX: 1-734-454-4076

KOYO STEERING SYSTEMS OF U.S.A. INC.
 TEL: 1-734-454-7067 FAX: 1-734-454-7059

KOYO DE MÉXICO, S.A.
 TEL: 52-55-5358-0214, 0077 FAX: 52-55-5576-8827, 8871

KOYO LATIN AMERICA, S.A.
 TEL: 507-264-0921, 0977 FAX: 507-264-2782, 269-7578

KOYO ROLAMENTOS DO BRASIL LTDA.
 TEL: 55-11-3887-9173 FAX: 55-11-3887-3039

THAI KOYO CO., LTD.
 TEL: 66-38-533-310-7 FAX: 66-38-532-532-776

KOYO SINGAPORE BEARING (PTE.) LTD.
 TEL: 65-6274-2200 FAX: 65-6862-1623

PHILIPPINE KOYO BEARING CORPORATION
 TEL: 63-2-817-8881, 8901 FAX: 63-2-867-3148

KOYO SEIKO CO., LTD. SEOUL BRANCH
 TEL: 82-2-549-7922 FAX: 82-2-549-7923

KOYO SEIKO CO., LTD. BEIJING LIAISON OFFICE
 TEL: 86-10-6515-0037 FAX: 86-10-6515-0522

KOYO SEIKO CO., LTD. SHANGHAI LIAISON OFFICE
 TEL: 86-21-6237-5280 FAX: 86-21-6237-5277

*** **KOYO AUSTRALIA PTY. LTD.**
 TEL: 61-2-9638-2355 FAX: 61-2-9638-3368

KOYO SEIKO CO., LTD. EUROPEAN CENTRAL OFFICE
 TEL: 31-36-5383333 FAX: 31-36-5347212

KOYO STEERING EUROPE S.A.S
 TEL: 33-472-39-4444 FAX: 33-472-39-2188

*** **KOYO KULLAGER SCANDINAVIA A.B.**
 TEL: 46-8-594-212-00 FAX: 46-3-594-212-29

* **KOYO (U.K.) LTD.**
 TEL: 44-1908-289300 FAX: 44-1908-289333

*** **EUROPA-KOYO B.V.**
 TEL: 31-184-606800 FAX: 31-184-602572, 606857

KOYO ROMANIA REPRESENTATIVE OFFICE
 TEL: 40-21-410-4170, 4182, 0984 FAX: 40-21-410-1178

* **KOYO DEUTSCHLAND GMBH.**
 TEL: 49-40-67-9090-0 FAX: 49-40-67-9203-0

KOYO FRANCE S.A.
 TEL: 33-1-3998-4202 FAX: 33-1-3998-4244, 4249

KOYO IBERICA, S.A.
 TEL: 34-91-329-0818 FAX: 34-91-747-1194

KOYO ITALIA S.R.L.
 TEL: 39-02-2951-0844 FAX: 39-02-2951-0954

(KOYO SEIKO CO., LTD. (Japan) is certified to ISO9001.
 *QS-9000 certified. **ISO9001 certified. ***ISO 9002 certified.)



ISO9001/TS-16949
 Certificate No.927265

● Value & Technology

CAT. NO. 198E
 Printed in Japan '03. 3-1CT ('96.5)